ENGengineering

Subject Engineering Study and Main Size Assessment
Replacement of Existing 6" HP Gas Main with 16" HP Main
Route 173 from Hunt Club Rd to Route 45

Date July 11, 2012

Executive Summary

The following report and map printouts detail the SynerGEE Stoner simulation study that was performed in order to justify the decision by NSG to replace 6" HP gas main in RTE 173 from RTE45 to Hunt Club Road with 16" HP gas main. Several model iterations were conducted using both main sizes and the following design assumptions:

- The primary study was conducted using a -15 degree Fahrenheit heating degree day model
- HP gas main along RTE 45 north of Washington Street has already been upgraded from 6" main to 16" main
- Load upon Regulator 001 was increased by 30% to simulate the project demand growth of the Clublands subdivision south of the intermediate pressure regulator
- The Edwards Road station has an existing maximum flow rate of 2,000 mscfh
- The Lake Cook Road station is set as flow control to 2,800 mscfh
- The Grayslake station is capable of meeting the remainder of the system's gas demands
- For scenarios modeled to a 0 degree Fahrenheit heating degree day model, the -15 degree model is used with a conversion factor of 0.88 applied broadly to all of the segment flow rates

The study first modeled the existing conditions and the effect of upgrading main size in RTE 173. Additional steps were then taken to introduce several scenarios that would test system reliability and flexibility between the two main sizes. These new variables included shutting in the Grayslake station completely, changing the model demands by using a 0 degree Fahrenheit degree day model, and gradually reducing the system supply through the Grayslake station allowing for increased supply through the Edwards Road station.

The 16" HP main responded better than the 6" HP main when introduced to the new variables during the various iterations. However, the study showed that it was not possible to completely shut in the Grayslake station under either the -15 degree or 0 degree model. As expected, overall system failure was lessened when 16" main was modeled. When reduction to the system supply of the Grayslake station was studied, it was shown that the 16" main allowed for a greater capacity to manipulate source flow into the system while still maintaining minimal pressure drops along the RTE 45 corridor of the HP system. Consideration should be made that these iterations allowed the Edwards Road station to exceed an assumed maximum flow of 2000 mscfh to account for system demands. This may not be a feasible scenario given existing station equipment. Further studies would need to be conducted to investigate the Edwards Road station's capacity.

Overall, the findings of the study supported NSG's decision to install 16" HP main in RTE 173. The new main size allowed for greater system capability with both flow and pressure considerations in the HP system when compared to existing conditions.

RTE173 & RTE173- Stoner Maps (Pg. 1 & 2)

This scenario represents the starting point for the study, depicting what the existing conditions were assumed to be before any changes were modeled. The HP gas main in RTE 173 from RTE 45 to Hunt Club Road exists as 6". At Hunt Club Road the HP system pressure is shown as 246 PSI. At RTE 45 the HP system pressure falls to 212 PSI. The gas flow through the 6" HP main along RTE 173 is shown as 451 mscfh.

RTE173A- Stoner Maps (Pg. 3)

This scenario represents the impact on our system of removing the existing 6" HP main along RTE 173 from Hunt Club Road to RTE 45. It was done to verify whether the HP main is still needed at all, regardless of size (not considering gas main hits). This step showed that there is a general loss of pressure along the HP main running along RTE 45. At the northern end of the HP main at RTE 45 and RTE 173, the pressure dropped from 212 PSI to 132 PSI.

RTE173B & RTE173 PIPE A- Stoner Map (Pg. 4 & 5)

This scenario represents the system with the 6" HP gas main segments along RTE 173 replaced with 16" HP main. The map shows a reduced pressure drop between the two previous comparison points along RTE 173. AT Hunt Club Road the HP system pressure is shown as 245 PSI. At RTE 45 the HP system pressure increases to 244 PSI showing a pressure drop of about only 2 PSI along the new segment of 16" HP main. The gas flow through the HP main along RTE 173 has also increased to 868 mscfh from the 451 mscfh shown in the existing conditions map. The pressure at the inlet to Regulator 001 increases as well and the capacity of that facility remains above the downstream distribution system demands with the 30% forecasted demand growth. However, this model does pull more gas (2041 mscfh) from the Edwards Road station which exceeds its maximum capacity of 2000 mscfh.

RTE173C & RTE173D- Stoner Map (Pg. 6 & 7)

This scenario represents the system with the existing 6" HP gas main segments along RTE 173 as originally modeled, but with no gas supplied at the Grayslake station. It was done in an effort to determine if the system can sustain with only two feeds, the Edwards Road Station and the Lake Cook Road station. Due to the reduction of gas supply through the Grayslake Station, the Edwards Road station must flow more gas into the system to compensate. When the model is balanced, the output shows that the system fails in this scenario shown by system pressure dropping across the system and even going negative (in order to solve the numerical analysis). This shows that the system cannot be sustained without some amount of gas supply from the Grayslake station.

RTE173E & RTE173F-Stoner Map (Pg. 8 & 9)

This scenario represents the same model as the previously mentioned except that the 6" portion along RTE 173 upsized to the proposed 16" size. With no gas supply through the Grayslake station, this model also fails as system pressure fall. The only difference between the 6" scenario and this 16" scenario is that some of the system pressures within close proximity to the Edwards Road station are higher than the previous case.

RTE173G & RTE173H-Stoner Map (Pg. 10 & 11)

This scenario represents a repeat of the original model with the existing 6" main along RTE 173 with no supply through the Grayslake station with the exception that the model has been converted to a zero degree Fahrenheit heating degree day model. Although pressures do not drop as dramatically as the -15 degree heating day model, a failure to balance still occurs.

RTE173I & RTE173J-Stoner Map (Pg. 12 & 13)

This scenario represents the 16" main replacement along RTE 173 and no supply through the Grayslake station with the model converted to reflect a zero degree Fahrenheit heating degree day model. Although the model still fails to balance similar to the -15 degree heating day model, the pressure drops are reduced.

RTE173K-Stoner Map (Pg. 14)

This scenario represents the system with the existing 6" HP gas main segments along RTE 173 as originally modeled, but with a reduced gas flow supplied at the Grayslake station. It was done to determine the flexibility in gas supply options provided by main sizing. In this scenario a minimum flow needed from the Grayslake station to prevent system failure was found by gradually reducing flow at Grayslake until just before failure. As in previous steps, due to the reduction of gas supply through the Grayslake Station, the Edwards Road station must flow more gas into the system to compensate. The Grayslake minimum flow was found to be 8500 mscfh. At Hunt Club Road the HP system pressure is shown as 239 PSI. At RTE 45 the HP system pressure falls to 156 PSI. The gas flow leaving the Edwards Road station is shown as 3320 mscfh.

RTE173L- Stoner Map (Pg.15)

This scenario represents the same model as the previously mentioned except that the 6” portion along RTE 173 upsized to the proposed 16” size. The Grayslake minimum flow was found to decrease to 7500 mscfh. At Hunt Club Road the HP system pressure is shown as 232 PSI. At RTE 45 the HP system pressure falls to 228 PSI showing a pressure drop of about 4 PSI along the new segment of 16” HP main. The gas flow leaving the Edwards Road station is now shown as 4320 mscfh to compensate for the decrease in flow at the Grayslake station.

RTE173M-Stoner Map (Pg. 16)

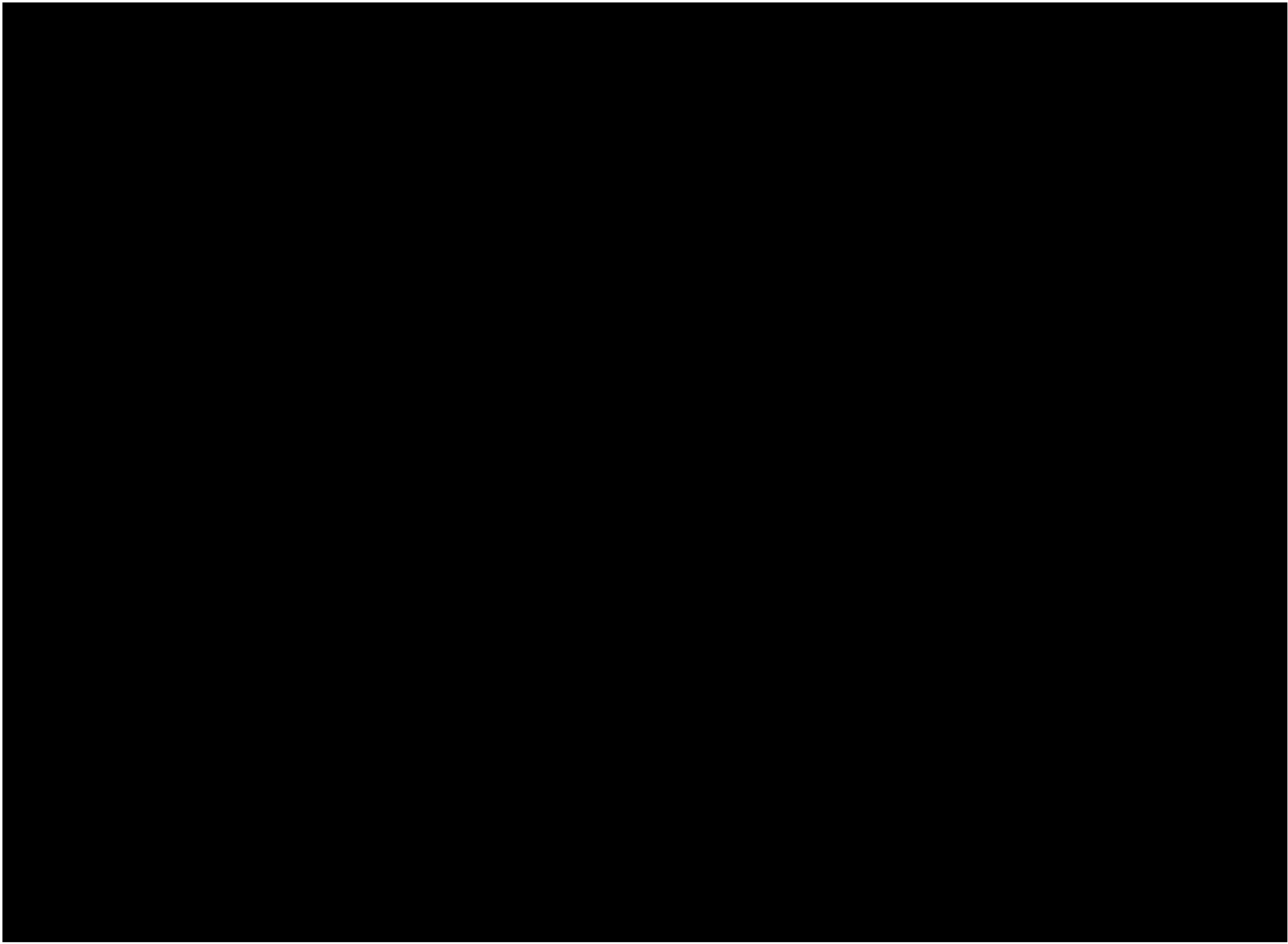
This scenario represents a repeat of the original model with the existing 6” main along RTE 173 and a reduced flow through the Grayslake station with the exception that the model has again been converted to a zero degree Fahrenheit heating degree day model. As in previous steps, a minimum flow needed from the Grayslake station to prevent system failure was found by gradually reducing flow at Grayslake until just before failure. The Grayslake minimum flow was now found to decrease to 7000 mscfh due to the decreased demand of the model. At Hunt Club Road the HP system pressure is shown as 239 PSI. At RTE 45 the HP system pressure falls to 156 PSI. The gas flow leaving the Edwards Road station is now shown as 3400 mscfh.

RTE173N-Stoner Map (Pg.17)

This scenario represents the same zero degree model as in the previous step except that the 6” portion along RTE 173 upsized to the proposed 16” size. The Grayslake minimum flow was found to decrease to 6000 mscfh. At Hunt Club Road the HP system pressure is shown as 232 PSI. At RTE 45 the HP system pressure falls to 228 PSI showing a pressure drop of about 4 PSI along the new segment of 16” HP main. The gas flow leaving the Edwards Road station is now shown as 4400 mscfh to compensate for the decrease in flow at the Grayslake station.

CONCLUSION

The results from the engineering study support the decision to replace the 6” HP gas main segments in RTE 173 with 16” HP gas main. The 16” main allows for greater system capacity along the Route 45 corridor feeding the northwest portion of the Northshore Gas territory. In addition, the increased gas main size will allow for greater system reliability and greater flexibility in station gas supply considerations.



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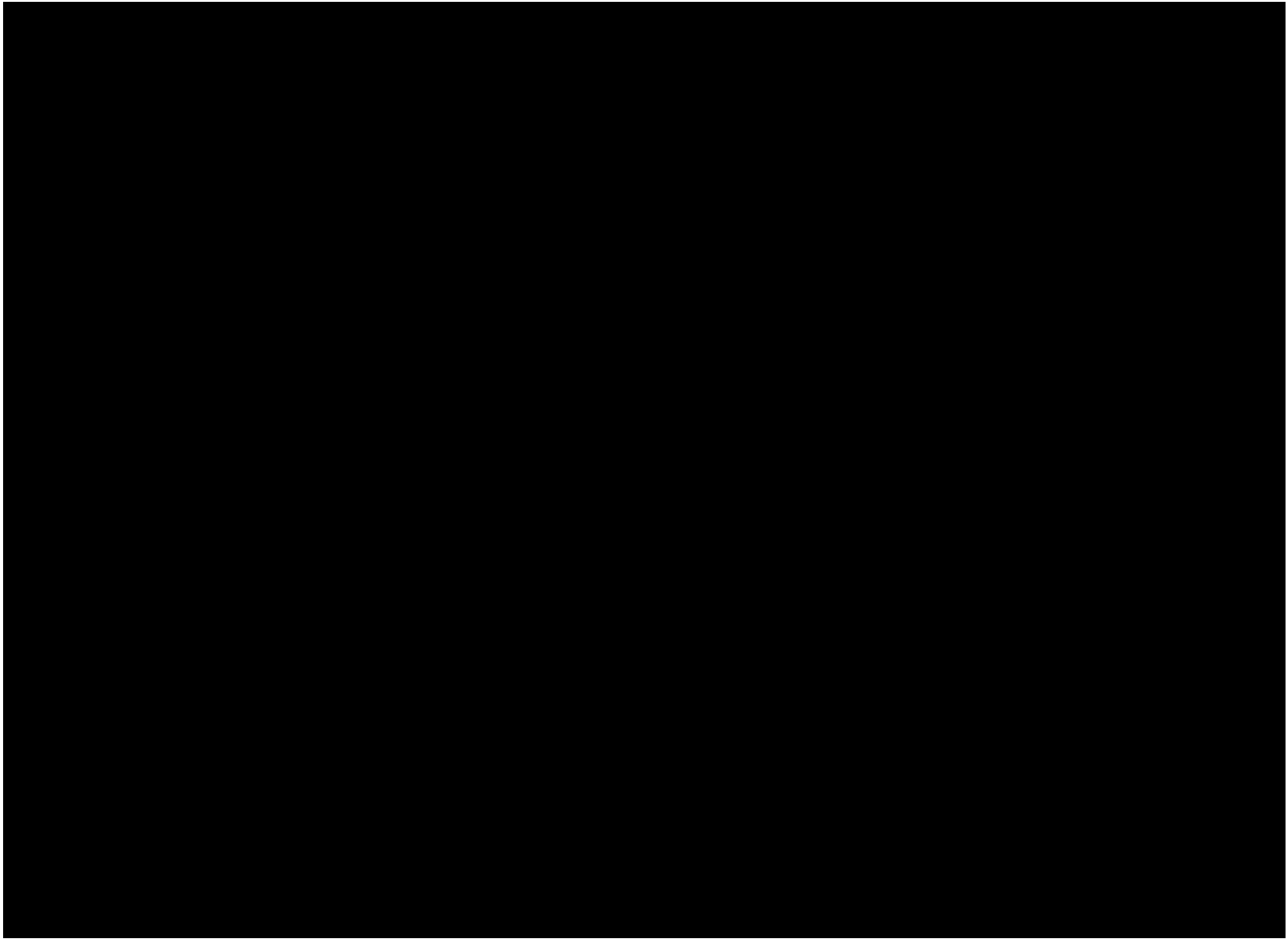

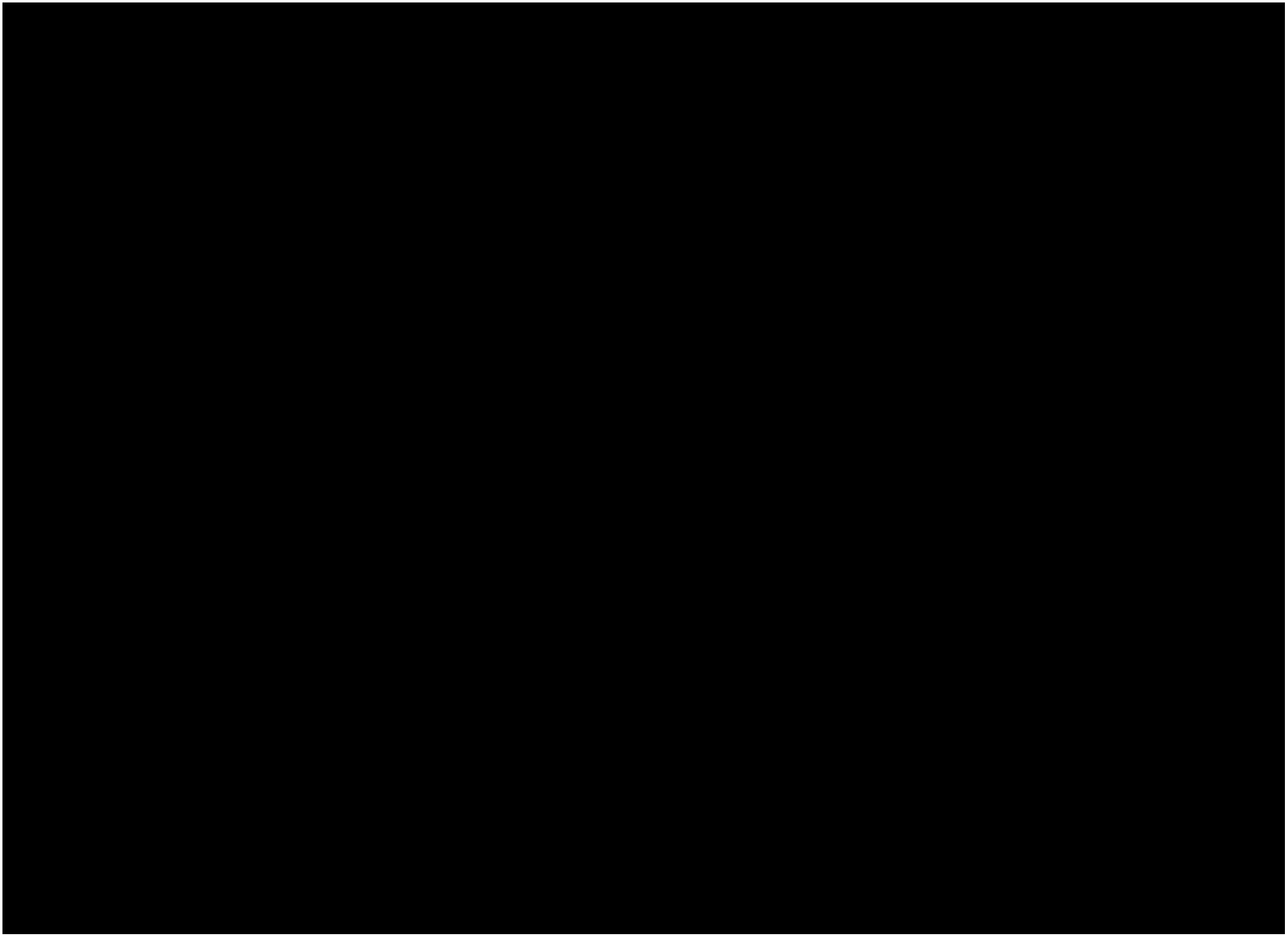

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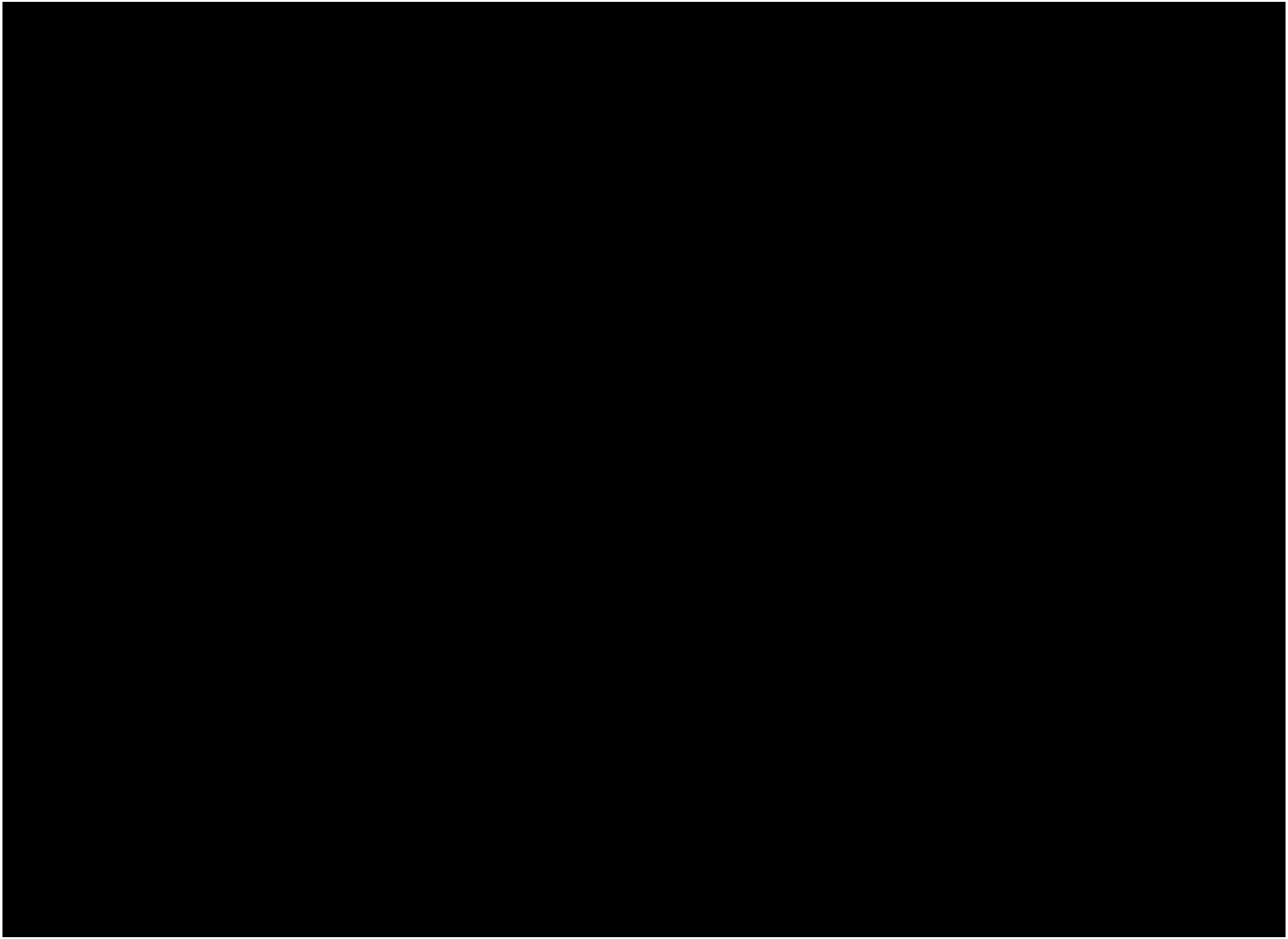
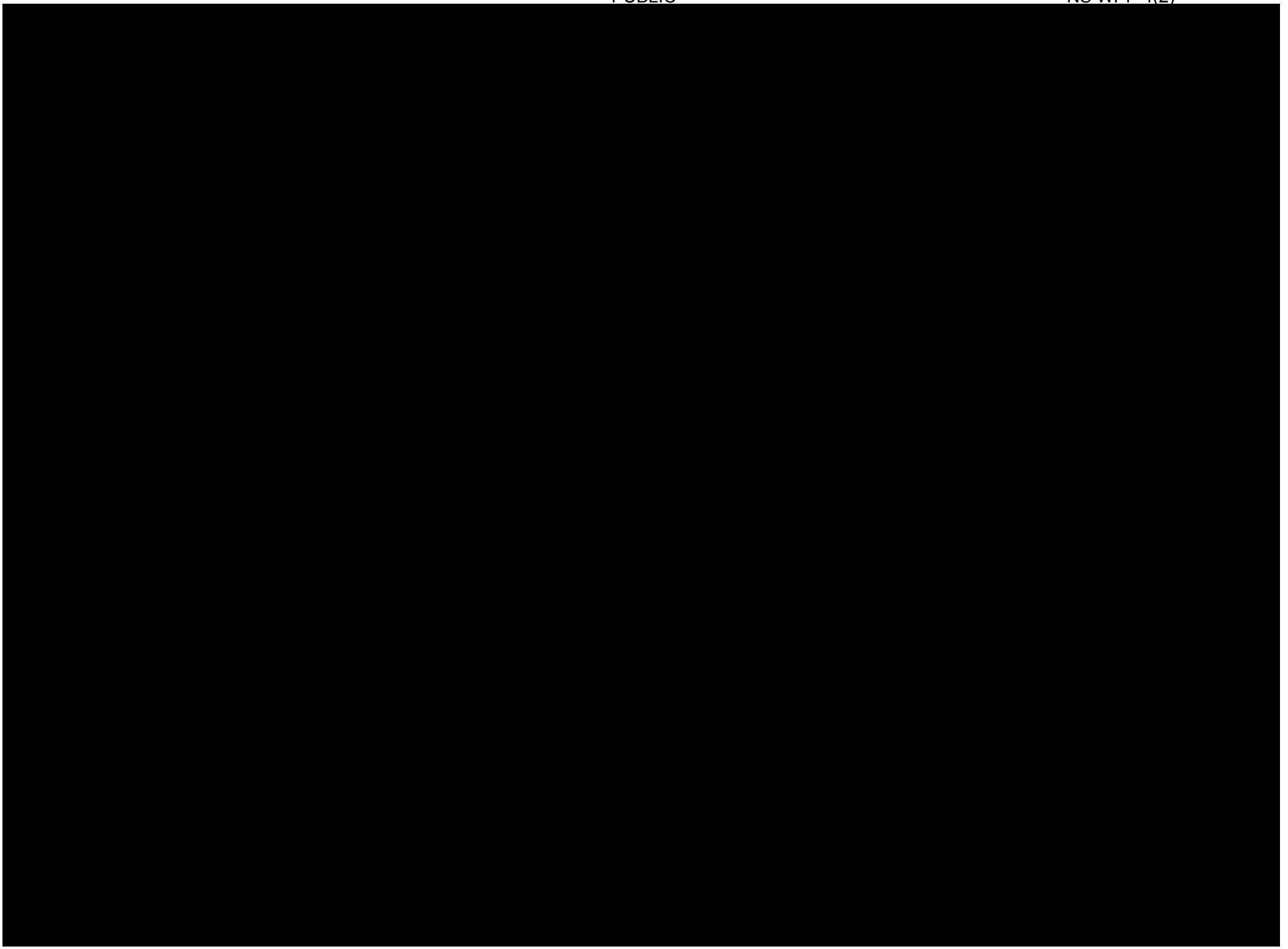
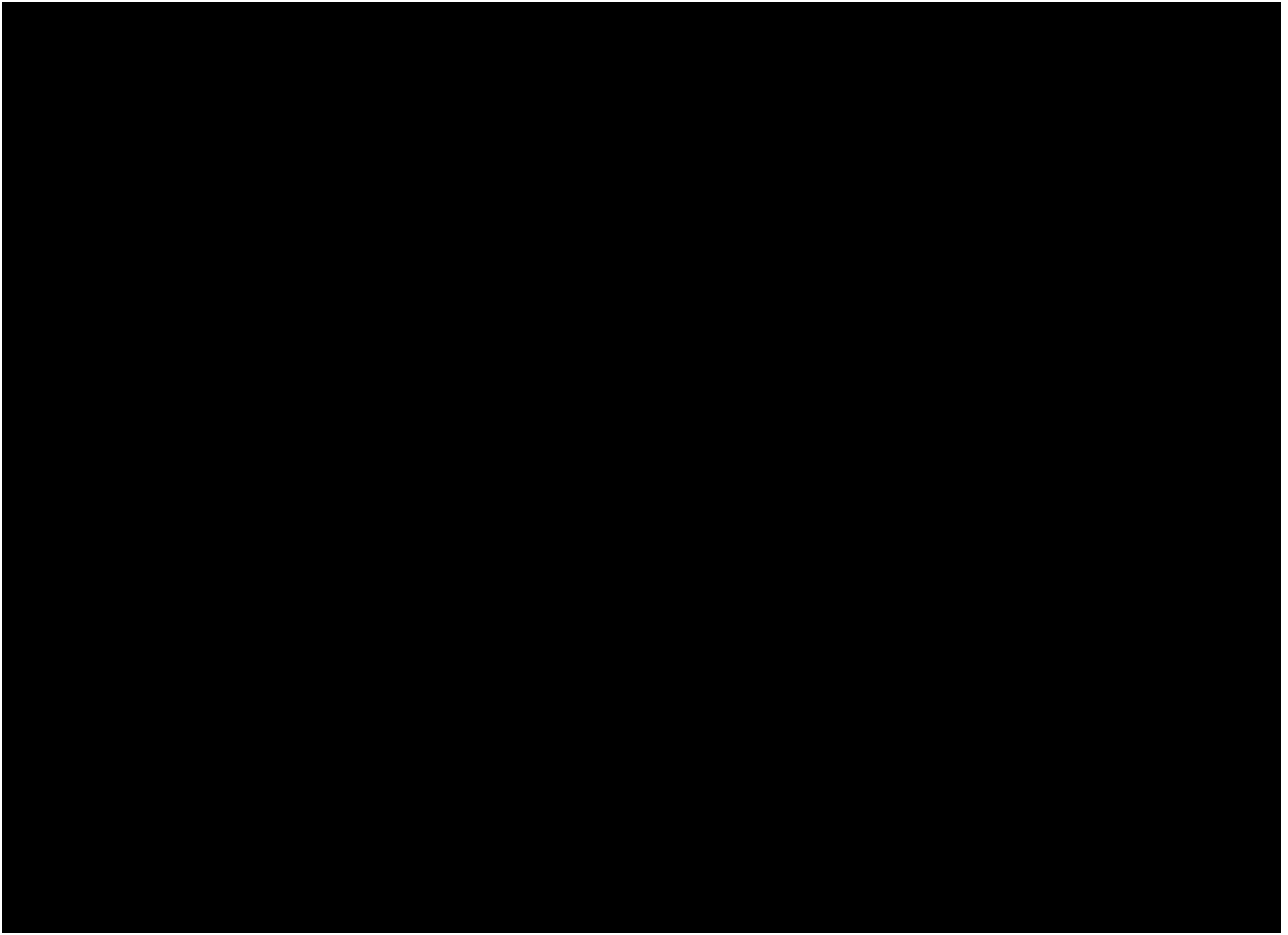
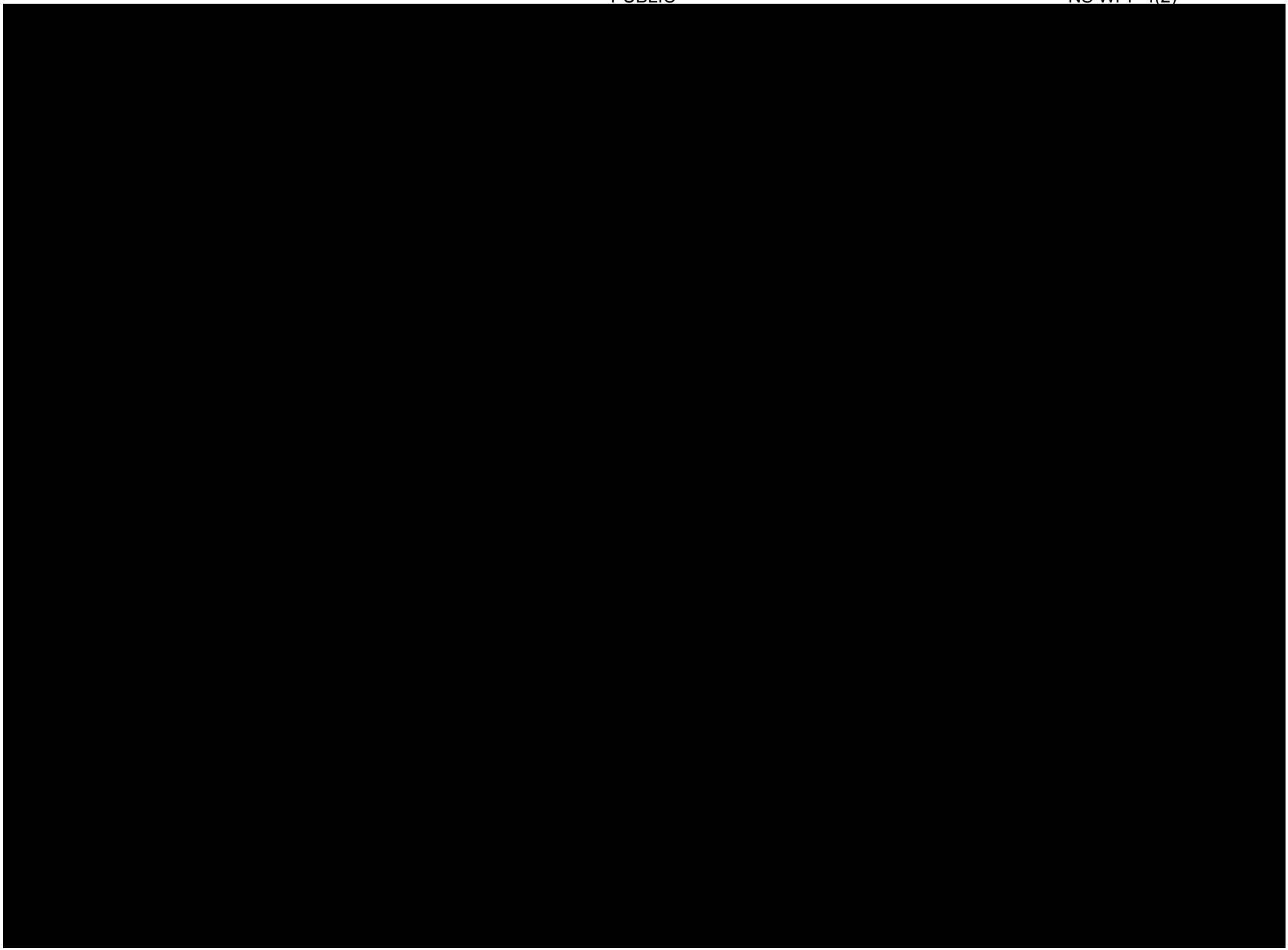








ENEngineering

Subject Engineering Study and Main Size Assessment
Replacement of Distribution Main Size-for-Size
Venetian Village System Improvement

Date July 11, 2012

Executive Summary

The following report and map printouts detail the SynerGEE Stoner simulation that was run to justify the decision to install size-for-size gas main replacement in the Venetian Village system improvement. The extents of the main replacement studied, as depicted in the maps, includes the distribution system southwest of Grand Ave. Several model iterations were conducted using a -15 degree Fahrenheit heating degree day model to study main sizing options for this area. All numbers on the maps indicate gas pressure in PSI.

The study first modeled the existing conditions of the system with steel main comprising the majority of the main in the area. The next iteration showed the effect of changing all steel main to plastic and maintaining size-for-size replacement. The effects of upgrading and downgrading the system were then studied through first downgrading all 4” main to 2” main and then through upgrading all 2” main to 4” main in the area.

The results of the study supported the decision to replace all steel main size-for-size for the Venetian Village system improvement as no benefits were gained through any main resizing.

VENETIAN VILLAGE & VENETIAN VILLAGE 1- Stoner Map (Pg. 1 & 2)

This scenario represents the starting point for the study, showing what the existing conditions were before any changes were modeled. The first map for this iteration, as well as the first map for all subsequent iterations, shows the pipe size and type through the following color designations:

- Violet- 2" Steel Main
- Blue- 2" Plastic Main
- Dark Green- 4" Steel Main
- Bright Green- 4" Plastic Main
- Brown- 6" Steel Main
- Orange- 8" Steel Main

At its current state, the pressure low point shown in the Venetian Village area is 39.12 PSI.

VENETIAN VILLAGE A & VENETIAN VILLAGE B- Stoner Map (Pg. 3 & 4)

This scenario demonstrates a size-for-size replacement of all steel main for plastic main in the Venetian Village area. The pressure low point is now shown as 38.77 PSI representing a pressure drop of only .35 PSI.

VENETIAN VILLAGE C & VENETIAN VILLAGE D- Stoner Map (Pg. 5 & 6)

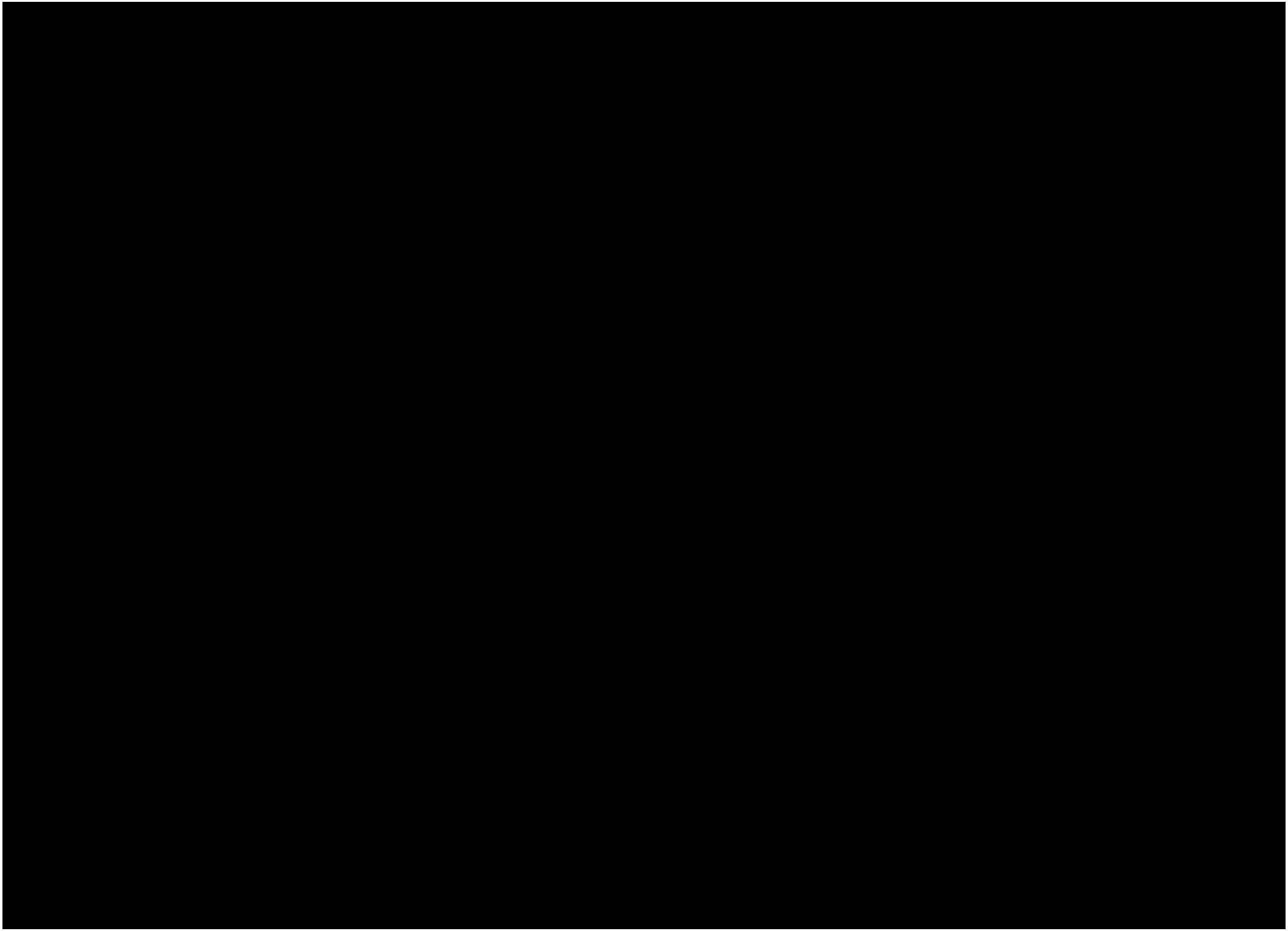
This scenario represents the impact on our system of replacing the 4" gas main segments located in the northeast portion of the area with 2" plastic gas main. This step was studied with the assumption that all 2" steel main in the area was replaced size-for-size with 2" plastic main, as per the previous step. This step shows that there is a general loss of pressure within Venetian Village when the 4" downgrade is made with a new pressure low point of 36.88 PSI. Therefore this main downgrade, while viable, should only be considered if NSG is comfortable with the resulting pressure drop throughout the area.

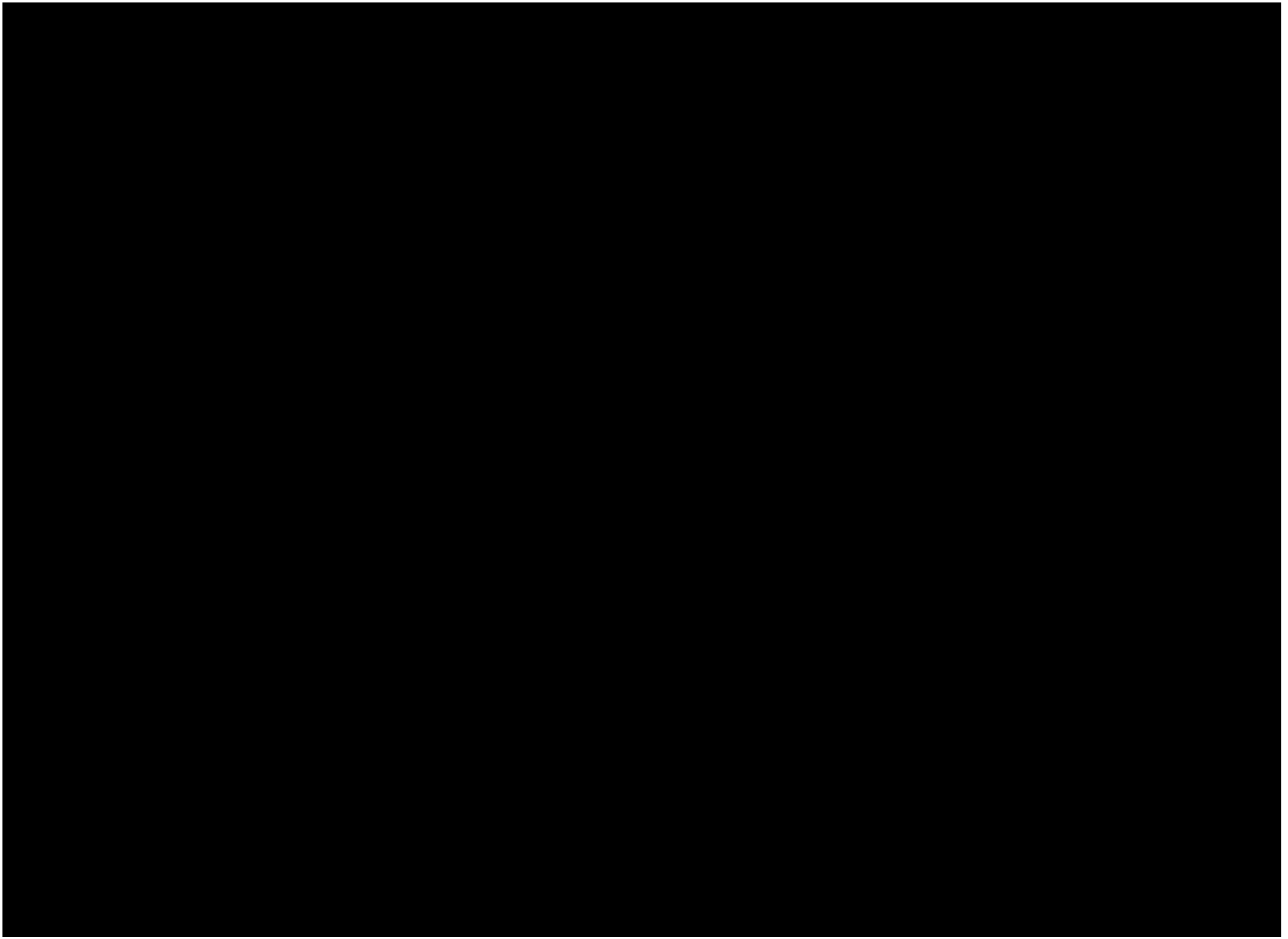
VENETIAN VILLAGE E & VENETIAN VILLAGE F- Stoner Map (Pg. 7 & 8)

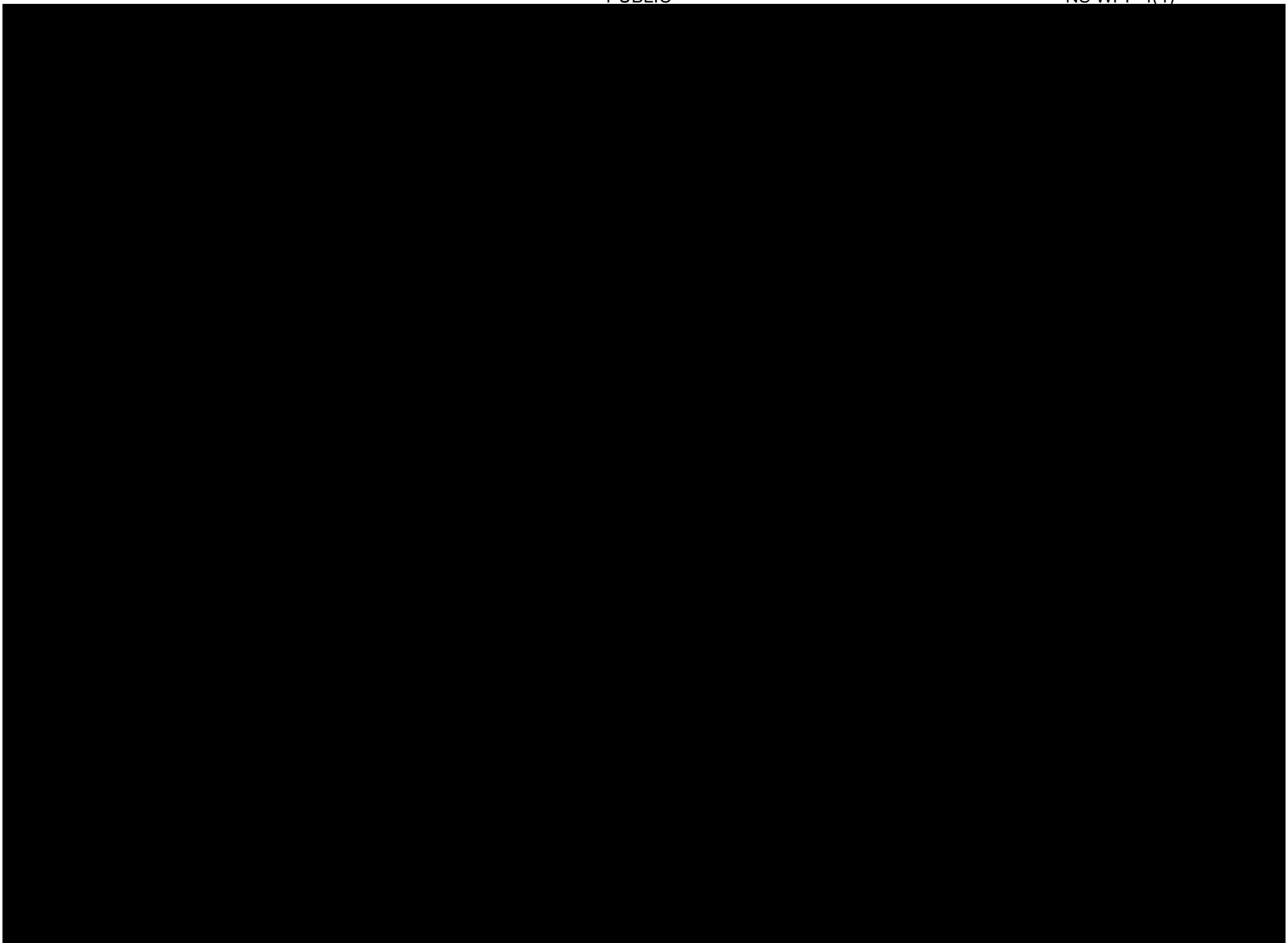
This scenario represents the impact on our system of replacing the 2" gas main segments, which comprises the majority of the Venetian Village area, with 4" plastic main. Again, this step was studied with the assumption that all 4" steel main in the area was replaced size-for-size with 4" plastic main, as per the previous step. This step showed that there is minimal pressure gain across the Knollwood Road area when this type of replacement is made with the new pressure low point shown as 40.81 PSI. This scenario represents a complete system upgrade in the area. With the pressure low point only rising 2.04 PSI in this extreme case, any single upgrade is shown to be unnecessary.

CONCLUSION

The results from the engineering study support the decision to replace the gas main size-for-size in the Venetian Village area. An upgrade or downgrade in main size in the area does not provide any substantial benefits and is therefore unnecessary.







ENengineering

Subject Engineering Study and Main Size Assessment
Replacement of Distribution Main Size-for-Size
Knollwood Road System Improvement

Date July 11, 2012

Executive Summary

The following report and map printouts detail the SynerGEE Stoner simulation that was run to justify the decision to install size-for-size gas main replacement in the Knollwood Road system improvement. The extents of the main replacement studied, as depicted in the maps, includes main east of Warrington Road, west of Meadowlark Lane, south of Woodvale Avenue, and North of Deerfield Road. Several model iterations were conducted using a -15 degree Fahrenheit heating degree day model to study main sizing options for this area. All numbers on the maps indicate gas pressure in PSI.

The study first modeled the existing conditions of the system with steel main comprising the majority of the main in the area. The next iteration showed the effect of changing all steel main to plastic and maintaining size-for-size replacement. The effects of upgrading and downgrading the system were then studied through first downgrading all 4” main to 2” main and then through upgrading all 2” main to 4” main in the area.

The results of the study supported the decision to replace all steel main size-for-size for the Knollwood Road system improvement as no benefits were gained through any main resizing.

KNOLLWOOD RD & KNOLLWOOD RD 1- Stoner Map (Pg. 1 & 2)

This scenario represents the starting point for the study, showing what the existing conditions were before any changes were modeled. The first map for this iteration, as well as the first map for all subsequent iterations, shows the pipe size and type through the following color designations:

- Violet- 2" Steel Main
- Blue- 2" Plastic Main
- Dark Green- 4" Steel Main
- Bright Green- 4" Plastic Main
- Brown- 6" Steel Main
- Orange- 8" Steel Main

At its current state, the pressure low point shown in the Knollwood Rd. area is 38.20 PSI.

KNOLLWOOD RD A & KNOLLWOOD RD B- Stoner Map (Pg. 3 & 4)

This scenario demonstrates a size-for-size replacement of all steel main for plastic main in the Knollwood Road area. The pressure low point is now shown as 37.94 PSI representing a pressure drop of only .26 PSI.

KNOLLWOOD RD C & KNOLLWOOD RD D- Stoner Map (Pg. 5 & 6)

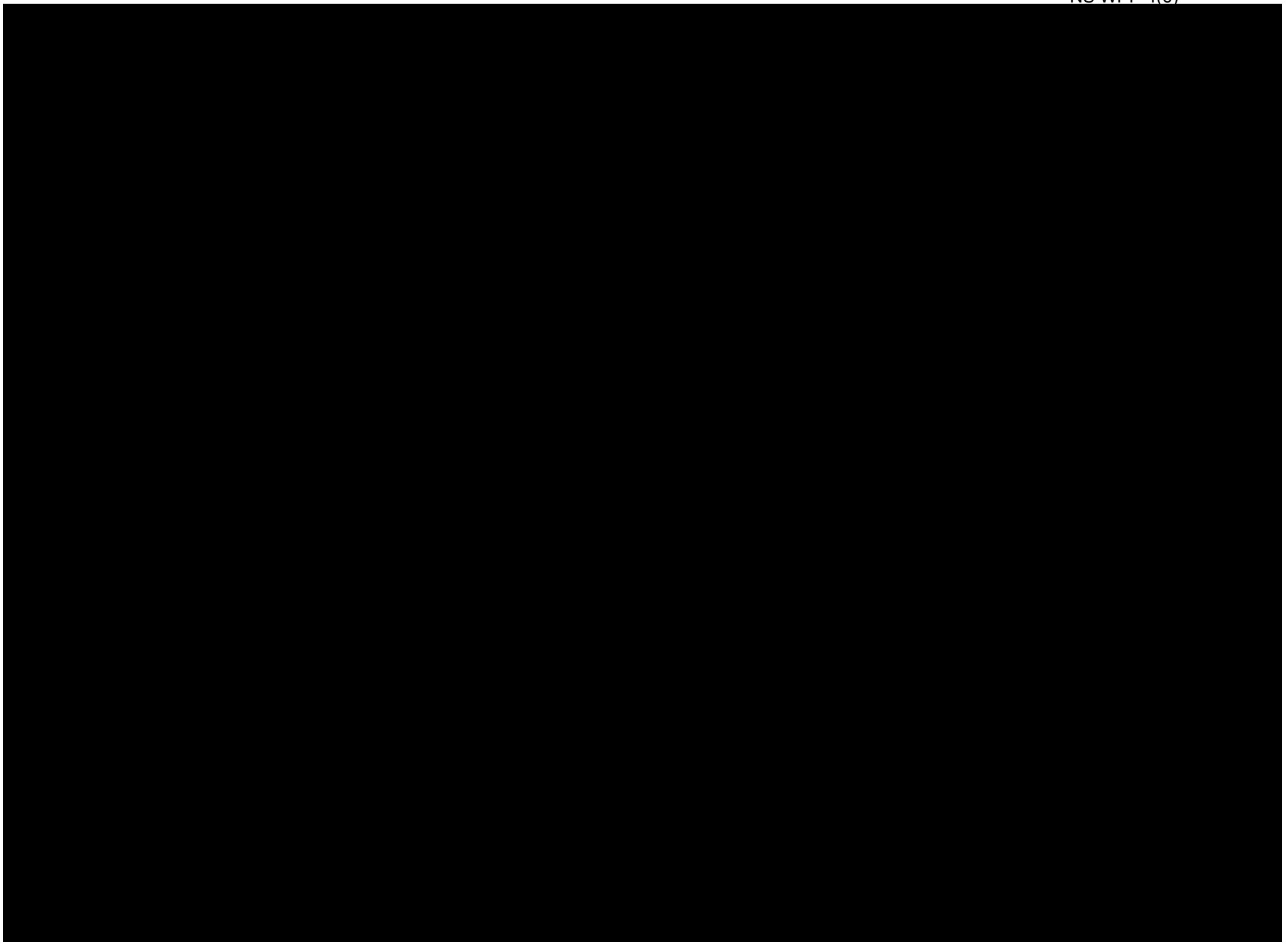
This scenario represents the impact on our system of replacing the 4" gas main segments located in the southwest portion of the area with 2" plastic gas main. This step was studied with the assumption that all 2" steel main in the area was replaced size-for-size with 2" plastic main, as per the previous step. This step shows that there is a general loss of pressure within Knollwood Road when the 4" downgrade is made with a new pressure low point of 37.41 PSI. Therefore this main downgrade, while viable, should only be considered if NSG is comfortable with the resulting pressure drop throughout the area.

KNOLLWOOD RD E & KNOLLWOOD RD F- Stoner Map (Pg. 7 & 8)

This scenario represents the impact on our system of replacing the 2" gas main segments, which comprises the majority of the Knollwood Road area, with 4" plastic main. Again, this step was studied with the assumption that all 4" steel main in the area was replaced size-for-size with 4" plastic main, as per the previous step. This step showed that there is minimal pressure gain across the Knollwood Road area when this type of replacement is made with the new pressure low point shown as 39.96 PSI. This scenario represents a complete system upgrade in the area. With the pressure low point only rising 2.02 PSI in this extreme case, any single upgrade is shown to be unnecessary.

CONCLUSION

The results from the engineering study support the decision to replace the gas main size-for-size in the Knollwood Road area. An upgrade or downgrade in main size in the area does not provide any substantial benefits and is therefore unnecessary.



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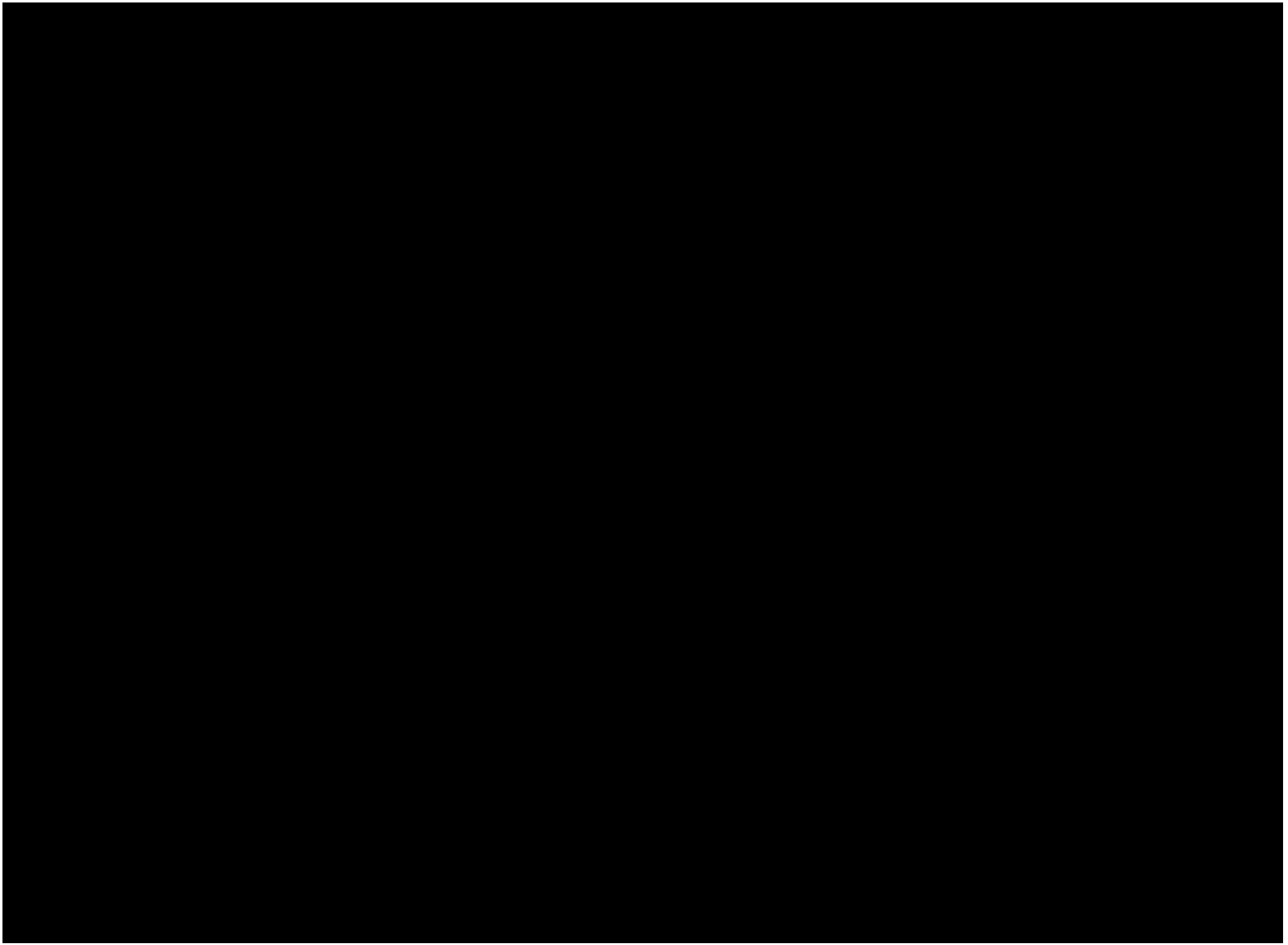

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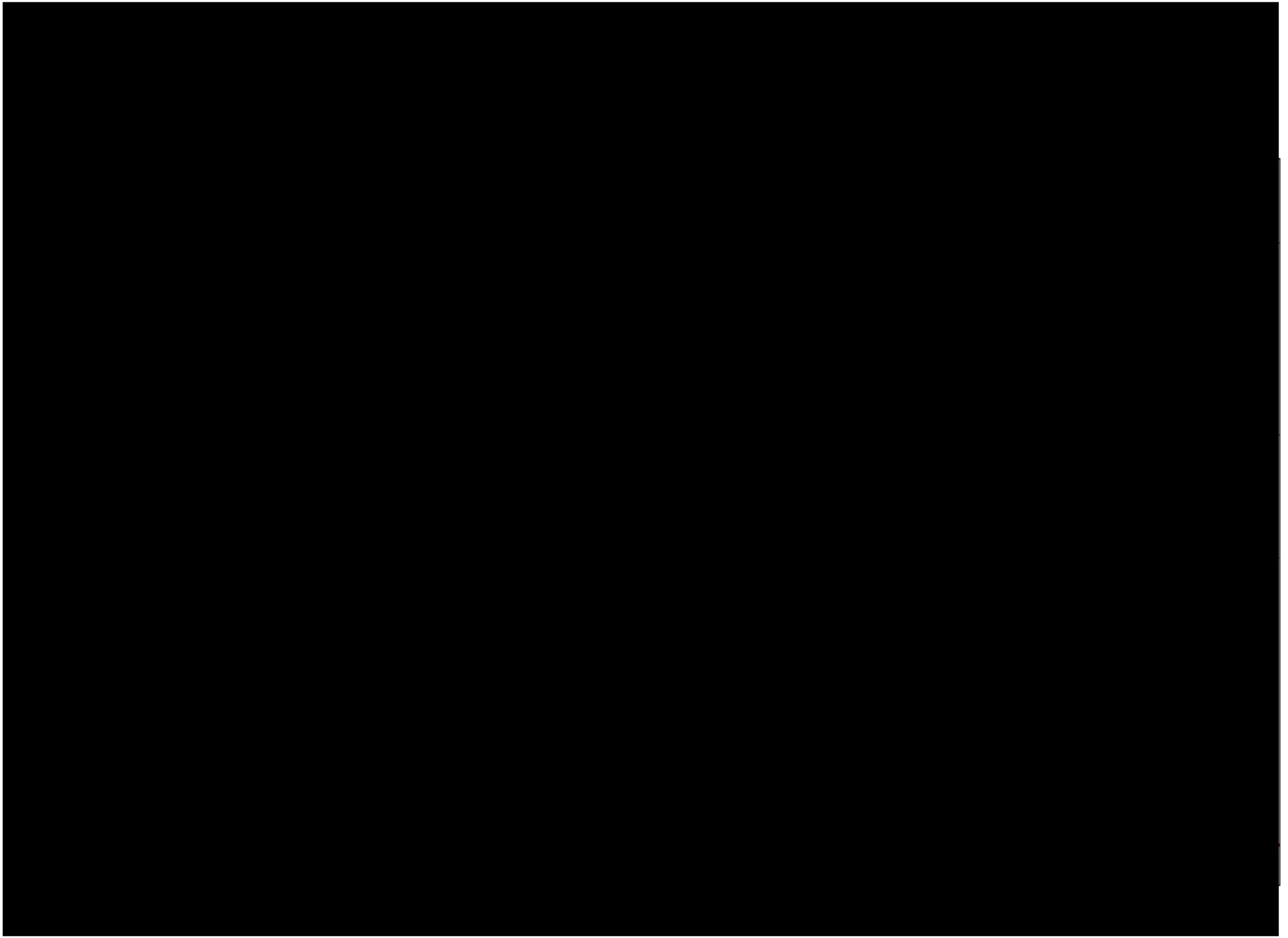

North Shore Gas Company
Gas Stored Underground - Gas Utilities

For the Portion of the Facility Owned, Contracted, Leased, etc., during the test year,

Line No.	Location and Operator of Storage Facility (A)	c-1 Maximum Daily Deliverability on a Typical Peak Day (B)	c-2 Expected Daily Delivery On Peak Day (C)	c-3 Type of Transportation Used (D)
1	The Peoples Gas Light and Coke Company:Manlove Field	Per Storage Service Agreement with The Peoples Gas Light and Coke Co.	See response to c-1	Not Applicable
2	Champaign County, Fisher Ill			
3				
4	DSS	Per NGPL tariff Rate Schedule DSS, November 1 through February 15, the Shipper's Withdrawal Quantity is 100% of its Maximum Daily Quantity. Also per NGPL tariff Rate Schedule DSS, a Shipper's firm right to withdraw gas under delivered firm storage service over any consecutive fifteen (15) day period may not exceed that Shipper's average WQ over that period multiplied by ten (10).	See response to c-1	Firm Transportation Embedded in Service/Rate
5	NGPL			
6				
7				
8				
9	NSS	Per NGPL tariff Rate Schedule NSS, a Shipper's Withdrawal Quantity will equal one hundred percent of its Maximum Daily Quantity when its inventory level in its storage account exceeds fifty percent (50%) of its maximum storage volume.	See response to c-1	Additional Firm Transportation is Purchased
10	NGPL			
11				
12	FSS	Per ANR tariff General Terms and Conditions and Rate Schedule FSS, a Shipper's Withdrawal Quantity will equal one hundred percent of its Maximum Daily Quantity when its inventory level in its storage account exceeds twenty percent (20%) of its maximum storage value.	See response to c-1	Additional Firm Transportation is Purchased
13	ANR			
14				
15				

16 c-4. North Shore Gas Company accounts for its storage inventory levels with one central pool for all storage services.

The attached confidential Excel spreadsheet printout is the Summary Report from the Gas Dispatch Model run used to develop the test year supply portfolio. The Gas Dispatch model is run using the "What's Best" linear programming optimization software, which is commercially available from LINDO Systems, Inc. in Chicago. If needed, the entire Excel file can be viewed in our offices.

Please note that the NGPL NSS MSV on this workpaper is offset by one month from the corresponding Maximum Working Gas Inv. Volume on Schedule F-8.

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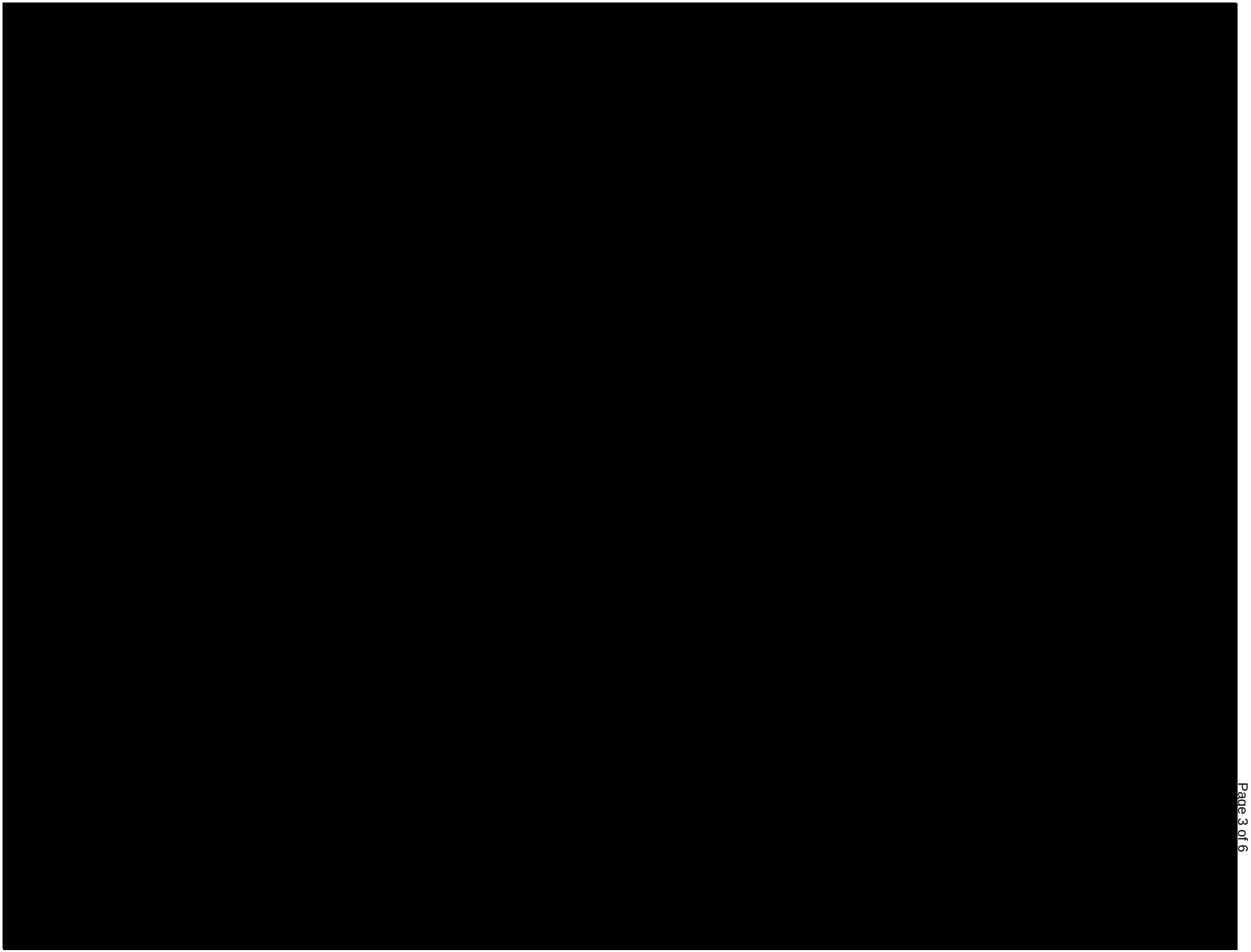
North Shore Gas Company
Supply Forecast in MDth

Rate Case Dispatch

Rate Case Dispatch

North Shore Gas Company

Supply Forecast in MDth



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North Shore Gas Company
Supply Forecast in MDth

Rate Case Dispatch

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North Shore Gas Company
Supply Forecast in MDth

Rate Case Dispatch

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North Shore Gas Company
Supply Forecast in MDth

Rate Case Dispatch

c) (1) The replenishment rate is not expected to change for different levels of inventory.

c) (2) The basis for the replenishment rate assumes that, given available supply, twelve truckloads of propane at approximately 9,200 gallons per truckload can be unloaded per day.