



MEMORANDUM

TO: David D'Amico, Director of Public Services, Town of Medway
FROM: Michael Sanders, PE, Kleinfelder
DATE : 6/12/2019
SUBJECT: **Additional Water System Hydraulic Analysis for Timber Crest Estates Development**
CC: Kirsten Ryan, Kleinfelder; file

This memorandum has been prepared to summarize Kleinfelder's additional hydraulic analysis results for the proposed Timber Crest Estates Development in the Town of Medway.

1 PURPOSE

The purpose of this hydraulic analysis is to evaluate impacts to domestic water and fire flow availability within, and in the vicinity of Timber Crest Estates due to the proposed construction of 136 single family homes. This analysis is necessary as the Town's plans for water main upgrades on Holliston Street have changed since the prior hydraulic analysis in 2017. In 2017, Kleinfelder evaluated seven scenarios for water service to the Timber Crest Estates that was based on replacement of the Holliston Street water main. Results for those scenarios were reported in a Technical Memorandum dated March 3, 2017.

2 SCOPE OF WORK

The scope of work consists of utilizing the Town's existing water distribution system hydraulic model to estimate the availability of water flow and water pressure in the vicinity of the development. Kleinfelder performed the hydraulic model simulations utilizing WaterGEMS hydraulic modeling software by Bentley Systems, Inc. The distribution system model was prepared by Tata & Howard in the early 2000's, updated by Weston & Sampson in 2010 and updated by Kleinfelder in 2017. For details of the water model updates and additional calibration completed by Kleinfelder, refer to the Technical Memorandum dated March 3, 2017.

The two scope items are:

1. Review and verify estimates for potable water demand and fire protection requirements for the proposed development based on sewer flow estimates and fire protection requirements provided by the developer's engineer. Kleinfelder will develop estimates using industry standard guidance if necessary.
2. Perform computer hydraulic analyses, utilizing the Town's updated system model, to determine the availability of water (flow and pressure) at the location of the proposed development and nearby locations. Compare the computer hydraulic model results for



water availability with the water demands (estimated potable water demand and fire protection requirements) of the proposed development for four additional scenarios.

3 SCENARIOS EVALUATED

Kleinfelder evaluated four additional proposed water main layouts and sizes within the development based on a plan titled "Timber Crest Estates & Kingsbury Village Water Connection Presentation" dated 5/1/2019 by Outback Engineers. This plan shows water mains forming a network in the proposed development. The connections to the existing Town of Medway water system are shown at Winthrop Street, Fairway Lane, Holliston Street and Ohlson Circle. For each of these proposed scenarios, Kleinfelder was asked to consider the Holliston Street water main upgraded from 6-inch diameter to 12-inch diameter from Lovering Street north to Ellis Street. In the prior analyses, the northern extent of this upgrade was the Town Line. Attachment 1 is annotated to show the specifics of each of the four scenarios.

In addition to those presented in the 2017 memo, Kleinfelder evaluated four additional water system scenarios using the projected 2028 town-wide peak hour demand of 1,590 gallons per minute (gpm). This demand projection is from the report by Weston & Sampson dated January 2010 and titled Water System Master Plan. Based on a letter from Outback Engineers dated 5/1/2019, peak hour demand for the development scenarios was estimated to be 98,138 gallons per day or 68 gpm. This demand was apportioned evenly to all 14 new model nodes that represent the Timber Crest Development water main network. According to generally accepted practice, the Town's supply wells were not considered active during fire flow simulations. The following list summarizes the four new scenarios. Refer to Attachment 1 for figures representing each scenario.

1. East-West connection 8-inch, Holliston Street upsize to 12-inch to Ellis Street
2. East-West connection 8-inch, Holliston Street upsize to 12-inch to Ellis Street, Kingsbury Drive upsize to 10-inch
3. East-West connection 10-inch to Linden Path, Holliston Street upsize to 12-inch to Ellis Street, Kingsbury Drive upsize to 10-inch
4. East-West connection 10-inch to Road D, Holliston Street upsize to 12-inch to Ellis Street, Kingsbury Drive upsize to 10-inch

4 DOMESTIC PRESSURE ANALYSIS

As described in our Technical Memorandum dated March 3, 2017, several locations in the vicinity of the proposed development currently experience pressures lower than 35 psi. Some examples are Lovering Street, Field Road, Fairway Lane, Howe Street, Redgate Drive and Fern Path. The change in domestic water pressure in the surrounding neighborhood due to the projected peak hour water consumption at the proposed development is predicted to be less than 0.25 psi in the most affected area north of the proposed development. This represents an imperceptible change in pressure. The small change in pressure is attributed to the proximity of the Lovering Street Water Tank which is about 1 mile away from the development. Additionally, like most water systems that provide both domestic service and fire protection service, the Town of Medway's water distribution system pipe network does not experience much head loss and associated pressure reduction even during periods of peak domestic demand. Therefore, the



main factors determining domestic pressure in the Town are the elevation of the homes, the level of the Town's storage tanks and the status of the supply pumps. These factors are not changed in the four new scenarios presented in this analysis.

Based on elevations shown in the provided plan, the domestic pressure for the proposed development will be in the range of 31 to 39 psi. The Massachusetts Department of Environmental Protection guideline for water distribution systems includes a recommended minimum pressure of 35 psi. Areas of this development above t 270 feet elevation will be at or below 35 psi. The simulated domestic water pressures are shown in Table 1 below.



Model Node Label/Location	MassDEP Guideline (psi)	Table 1: Domestic Water Pressure at selected model nodes (pounds per square inch) for various development scenarios			
		Scenario 1: 2030 with Timber Crest w/ 8" east-west connection and Kingsbury Drive and w/ Holliston St. 6" to 12" to Ellis St.	Scenario 2: 2030 with Timber Crest w/ 8" east-west connection, 10" Kingsbury Drive and w/ Holliston St. 6" to 12" to Ellis	Scenario 3: 2030 with Timber Crest w/ 8" east-west connection b/t Road D and Linden, 10" b/t Linden and Kingsbury, 10" Kingsbury Drive and w/ Holliston St. 6" to 12" to Ellis	Scenario 4: 2030 with Timber Crest w/ 10" east-west connection, 10" Kingsbury Drive and w/ Holliston St. 6" to 12" to Ellis
894 (Woodland Road dead-end)	35	38.7	38.7	38.7	38.7
J170 (Holliston Street south of Sun Valley Drive)	35	32.3*	32.2*	32.3*	32.2*
J-12 (eastern side of Ohlson Circle)	35	38.8	38.8	38.8	38.8
882 (Cider Mill Road dead-end)	35	33.3*	33.3*	33.3*	33.3*
872 (Fairway Lane at Algonquin Avenue)	35	33.1*	33.1*	33.1*	33.1*
J-19 (Road D and Timber Crest Drive)	35	33.1*	33.1*	33.1*	33.1*
J-30 (south end of Kingsbury Drive)	35	35.7	35.7	35.7	35.7

*Domestic pressure does not meet Massachusetts DEP Guidelines



5 FIRE FLOW ANALYSIS

In addition to meeting domestic needs, the Town of Medway's water distribution system must supply fire flow to the proposed development. Refer to Kleinfelder's Technical Memorandum dated March 3, 2017 for discussion of the Needed Fire Flows. It is estimated that 1,000 gpm is required for the proposed development and other values for existing buildings based on Table 2 below.

Table 2: Needed fire flow for one-and two-family dwellings

Distance between Buildings (ft)	Needed Fire Flow (gal/min)
More than 100	500
31 to 100	750
11 to 30	1,000
Less than 11	1,400

In order for a development to be adequately protected, the available fire flow must be greater than the recommended fire flow. As shown above, the needed fire flow for Timber Crest Estates is estimated to be 1,000 gpm. Additionally, the domestic demands of the new development must not reduce the available fire flow below the needed fire flow for the surrounding areas of the Town. Below is a table of locations in the northeast section of Medway that are most impacted by the new development. The location of each node is shown in Figure 1 below. The estimated needed fire flow is shown alongside the simulated available fire flow for the four scenarios in Table 3.

Figure 1: Fire flow node location plan (Not to Scale)

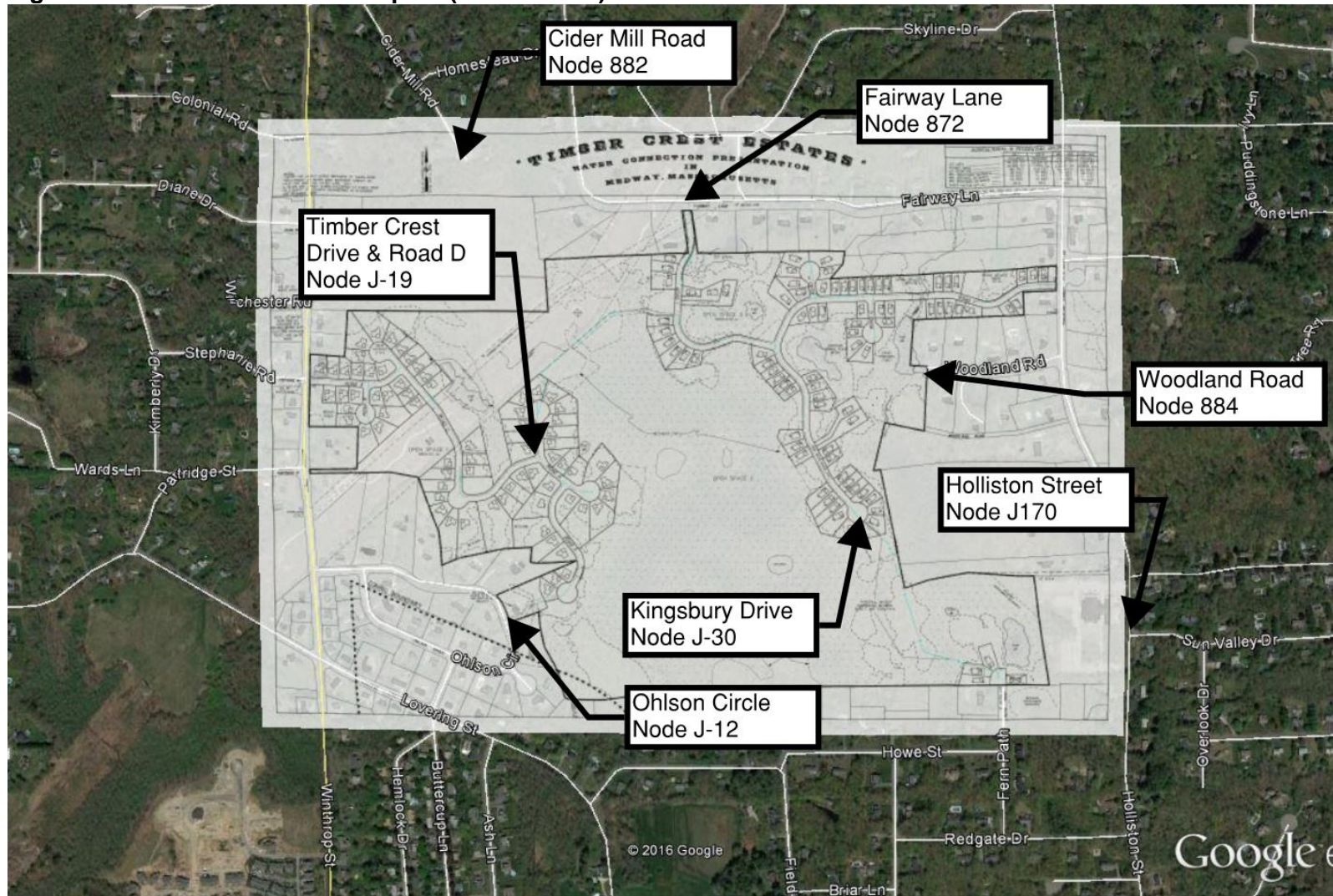




Table 3: Needed and Available fire flow at selected model nodes

Model Node Label/Location	Estimated Needed Fire Flow (gal/min)	Available fire flow at selected model nodes (gal/min) for various development scenarios			
		Scenario 1: 2030 with Timber Crest w/ 8" east-west connection and Kingsbury Drive and w/ Holliston St. 6" to 12" to Ellis St.	Scenario 2: 2030 with Timber Crest w/ 8" east-west connection, 10" Kingsbury Drive and w/ Holliston St. 6" to 12" to Ellis	Scenario 3: 2030 with Timber Crest w/ 8" east-west connection b/t Road D and Linden, 10" b/t Linden and Kingsbury, 10" Kingsbury Drive and w/ Holliston St. 6" to 12" to Ellis	Scenario 4: 2030 with Timber Crest w/ 10" east-west connection, 10" Kingsbury Drive and w/ Holliston St. 6" to 12" to Ellis
894 (Woodland Road dead-end)	500	800	820	830	835
J170 (Holliston Street south of Sun Valley Drive)	750	2,670	2,670	2,675	2,690
J-12 (eastern side of Ohlson Circle)	750	2,840	2,845	2,845	2,865
882 (Cider Mill Road dead-end)	750	915	915	915	925
872 (Fairway Lane at Algonquin Avenue)	750	1,510	1,510	1,510	1,620
J-19 (Road D and Timber Crest Drive)	1,000	1,935	1,940	1,943	2,035
J-30 (south end of Kingsbury Drive)	1,000	915*	1,210	1,296	1,380

*Available Fire Flow does not meet Needed Fire Flow



Table 3 above shows that available fire flow within the development is sufficient under scenarios 2, 3 and 4. Scenario 1 does not meet the development's fire flow requirements because the south end of Kingsbury Drive (J-30) is deficient.

Also, the addition of the Timber Crest Estates development does not reduce the available fire flows in the surrounding neighborhood below the needed fire flows.

6 RECOMMENDATIONS

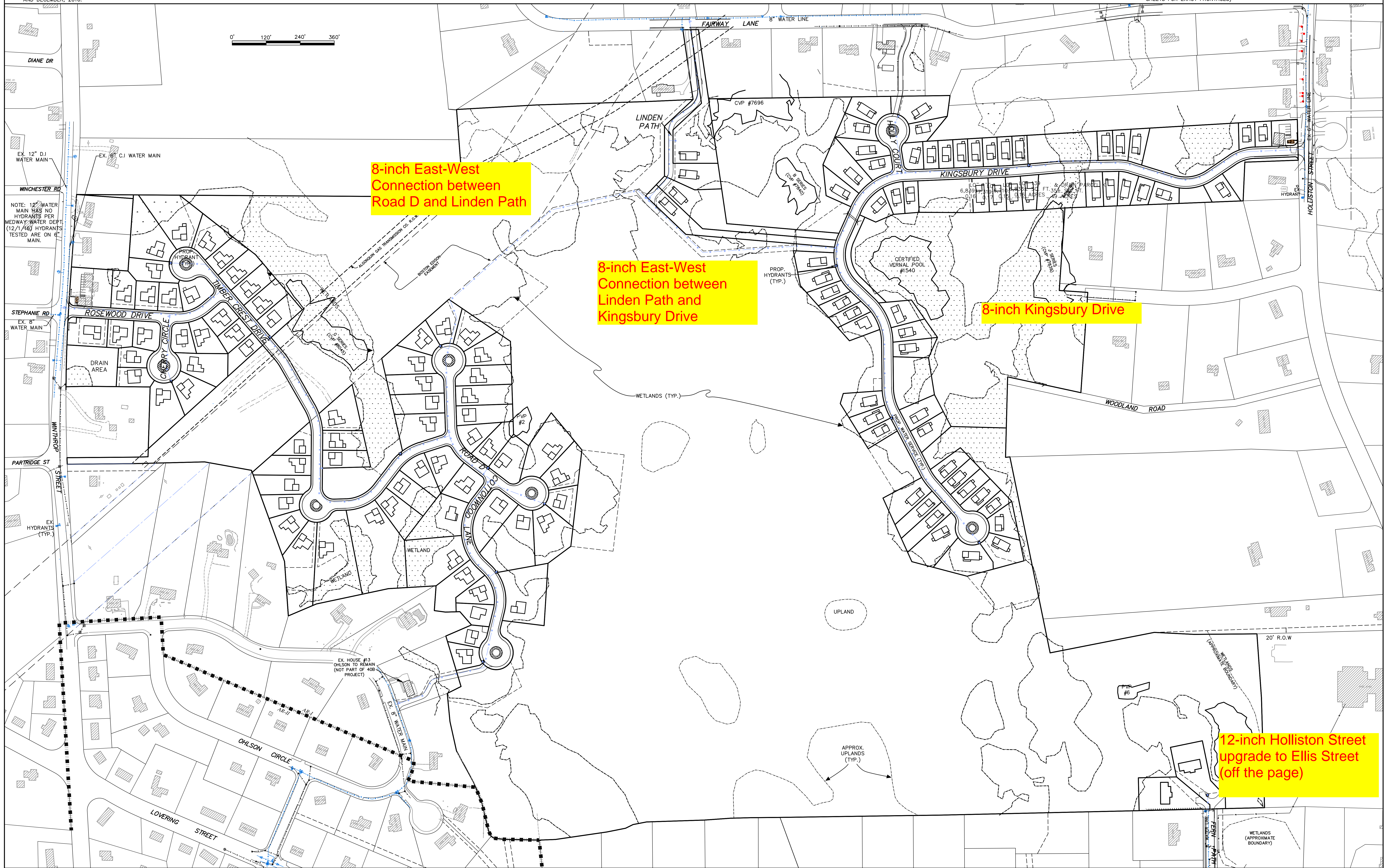
Kleinfelder recommends that the development include the improvements outlined in Scenario 2, 3 or 4 as described in Section 3. This requires that the water main in Kingsbury Drive be sized at least 10-inches in diameter. Additionally, Kleinfelder recommends that the developer mitigate the anticipated low domestic water pressures in this new development. This may involve installing a booster pump in each home or a single, larger pump system to serve the entire development that will increase system pressure above minimum MassDEP recommendations. A single, larger pump station will have long-term operation and maintenance requirements and the Town would not take ownership of such a system.



Attachment 1: Scenarios 1 – 4 figures

ZONING INFORMATION			
AGRICULTURAL & RESIDENTIAL DISTRICT I			
	AR-I	TIMBER CREST ESTATES	KINGSBURY VILLAGE
	REQUIRED	PROVIDED	PROVIDED
LOT AREA	44,000 S.F.	7,500 S.F.	6,000 S.F.
UPLAND AREA	22,000 S.F.	7,000 S.F.	4,000 S.F.
LOT FRONTAGE	180 FEET	50 FEET*	50 FEET*
MIN. FRONTYARD SETBACK	35 FEET	20 FEET	20 FEET
MIN. SIDEYARD SETBACK	15 FEET	7 FEET	7 FEET
MIN. REARYARD SETBACK	15 FEET	10 FEET	10 FEET
SHAPE FACTOR (P/A)	22.0	22.0	22.0

* EXCEPT LOTS 19, 48-50, 71-74, 117, AND 146-147 HAVE 25' MIN. (SEE LOTTING SHEETS FOR EXACT FRONTAGES)

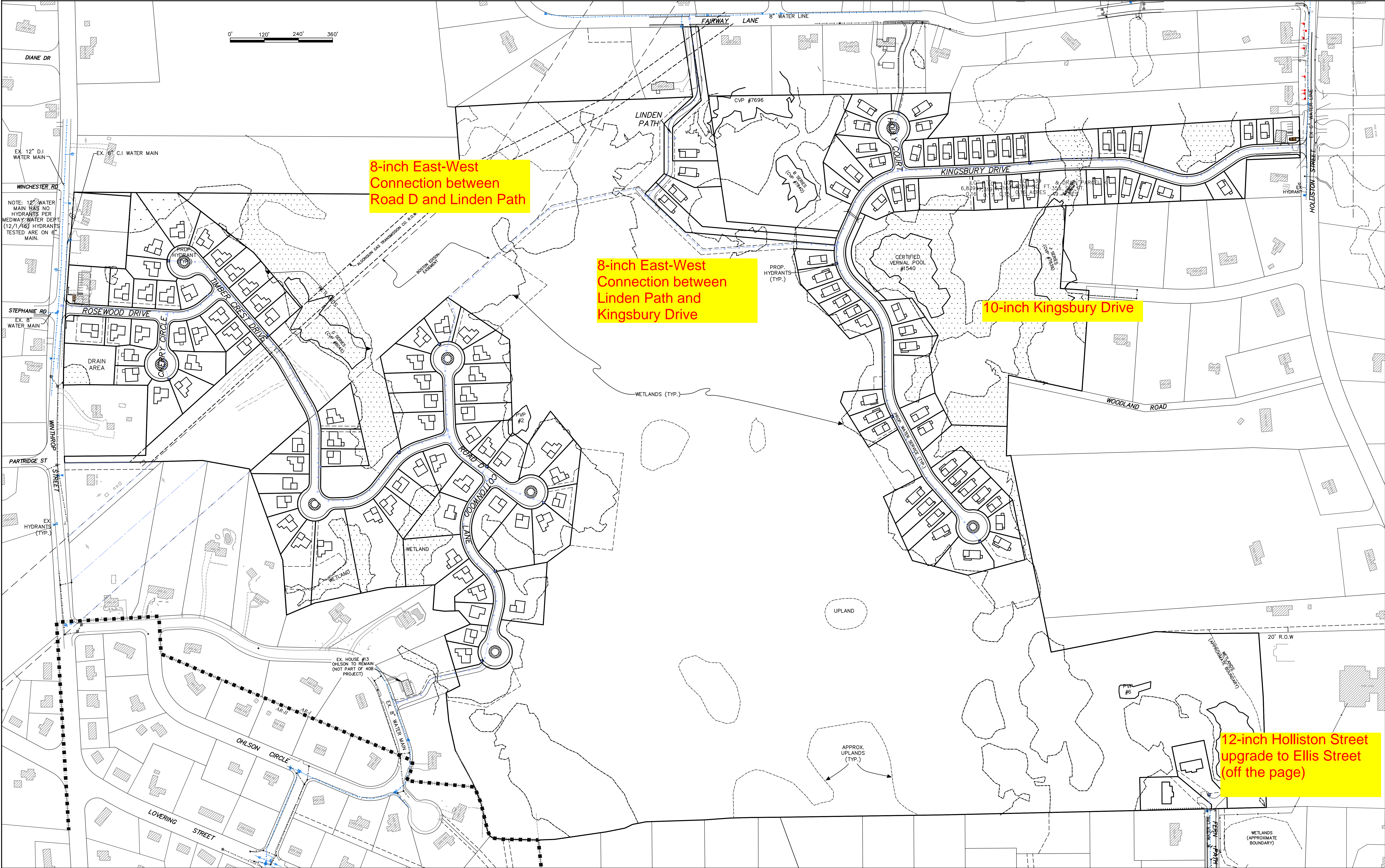


"TIMBER CREST ESTATES & KINGSBURY VILLAGE"
WATER CONNECTION PRESENTATION
IN
MEDWAY, MASSACHUSETTS

Scenario 2

ZONING INFORMATION			
AGRICULTURAL & RESIDENTIAL DISTRICT I			
	AR-1	TIMBER CREST ESTATES	KINGSBURY VILLAGE
LOT AREA	REQUIRED	PROVIDED	PROVIDED
UPLAND AREA	44,000 S.F.	7,500 S.F.	5,000 S.F.
LOT FRONTAGE	22,000 S.F.	7,000± S.F.	4,000± S.F.
MIN. FRONTYARD SETBACK	180 FEET	50 FEET*	50 FEET*
MIN. SIDEYARD SETBACK	35 FEET	20 FEET	20 FEET
MIN. REARYARD SETBACK	15 FEET	7 FEET	7 FEET
SHAPE FACTOR (P ² /A)	22.0	22.0	22.0

* EXCEPT LOTS 19, 48-50, 71-74, 117, AND 146-147 HAVE 25' MIN. (SEE LOTTING SHEETS FOR EXACT FRONTAGES)



8-inch East-West
Connection between
Road D and Linden Path

8-inch East-West
Connection between
Linden Path and
Kingsbury Drive

10-inch Kingsbury Drive

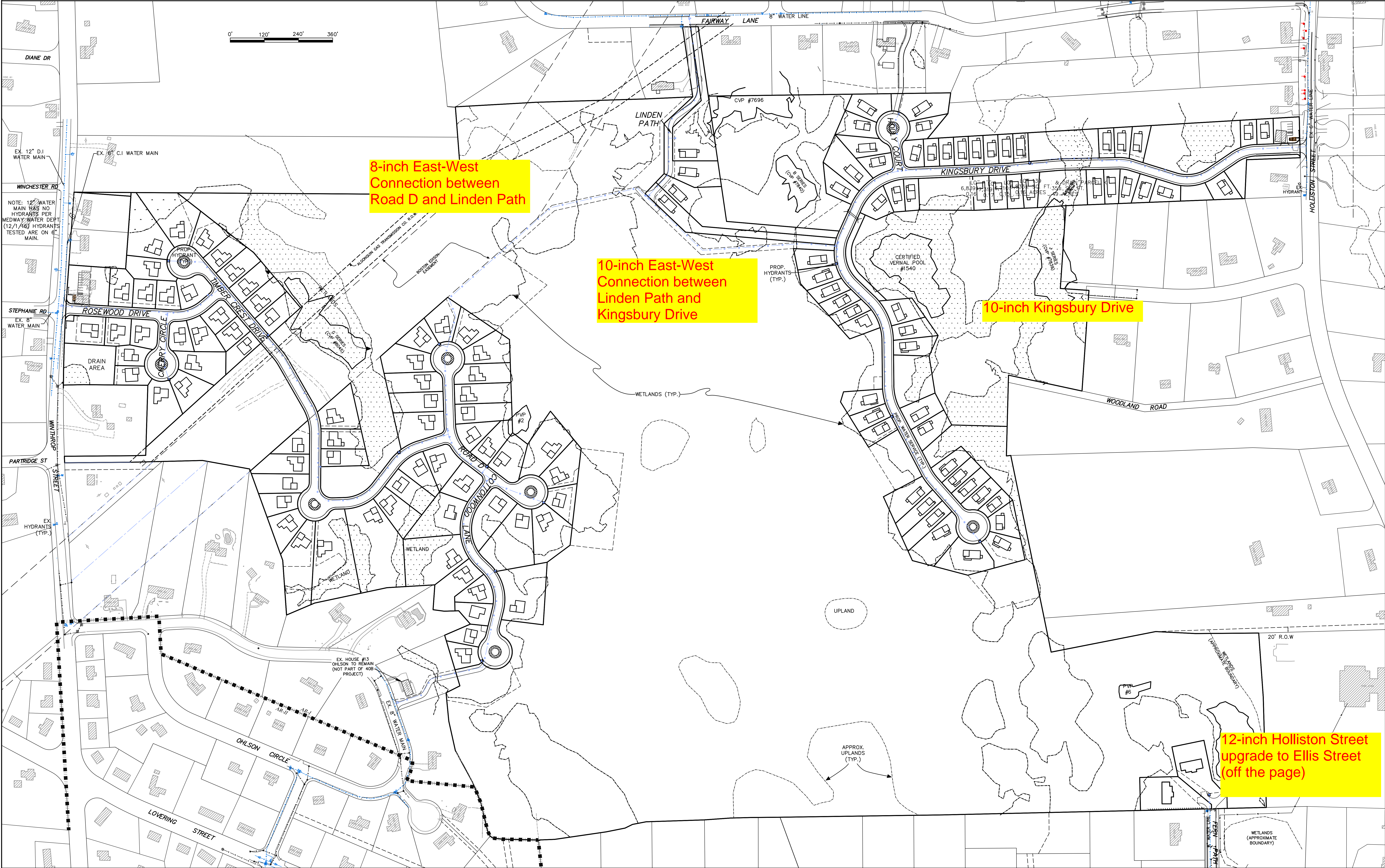
12-inch Holliston Street
upgrade to Ellis Street
(off the page)

"TIMBER CREST ESTATES & KINGSBURY VILLAGE"
WATER CONNECTION PRESENTATION
IN
MEDWAY, MASSACHUSETTS

Scenario 3

ZONING INFORMATION			
AGRICULTURAL & RESIDENTIAL DISTRICT I			
	AR-1	TIMBER CREST ESTATES	KINGSBURY VILLAGE
LOT AREA	REQUIRED	PROVIDED	PROVIDED
UPLAND AREA	44,000 S.F.	7,500 S.F.	5,000 S.F.
LOT FRONTAGE	22,000 S.F.	7,000± S.F.	4,000± S.F.
MIN. FRONTYARD SETBACK	180 FEET	50 FEET*	50 FEET*
MIN. SIDEYARD SETBACK	35 FEET	20 FEET	20 FEET
MIN. REARYARD SETBACK	15 FEET	7 FEET	7 FEET
SHAPE FACTOR (P ² /A)	22.0	22.0	22.0

* EXCEPT LOTS 19, 48-50, 71-74, 117, AND 146-147 HAVE 25' MIN. (SEE LOTTING SHEETS FOR EXACT FRONTAGES)



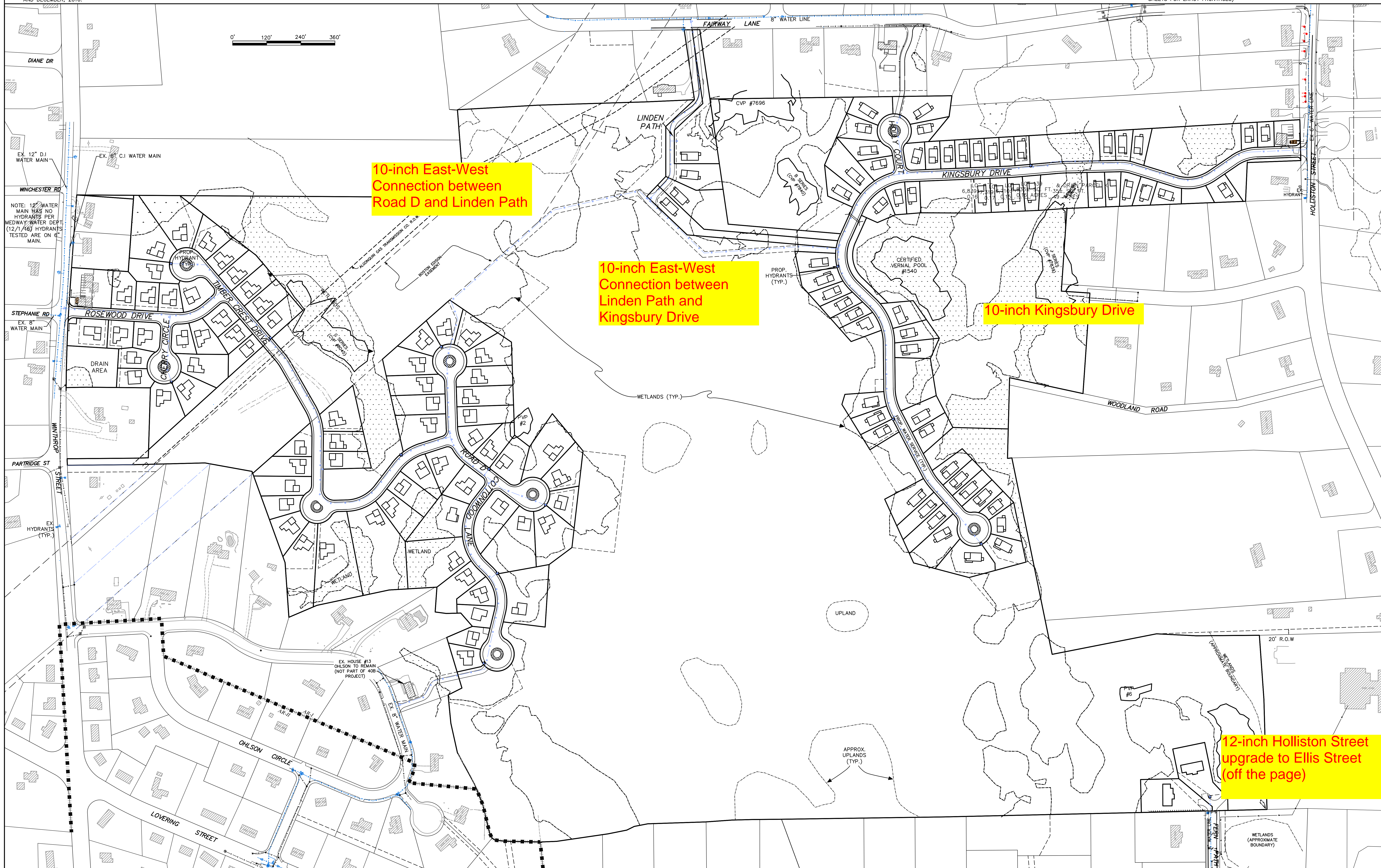
8-inch East-West
Connection between
Road D and Linden Path

10-inch East-West
Connection between
Linden Path and
Kingsbury Drive

10-inch Kingsbury Drive

12-inch Holliston Street
upgrade to Ellis Street
(off the page)

NOTES:
1. WATER LINE LAYOUT ALONG WINTHROP ST TAKEN FROM "REPLACEMENT OF WATER MAIN WINTHROP STREET" BY HALEY AND WARD INC. DATED JUNE, 1991.
2. WATER LINE LAYOUT ALONG HOLLISTON ST TAKEN FROM FIELD SURVEY BY COLONIAL ENGINEERING IN NOVEMBER AND DECEMBER, 2016.





Attachment 2: Technical Memorandum "Water System Hydraulic Analysis for Timber Crest Estates Development" dated March 3, 2017



MEMORANDUM

TO: David D'Amico, Acting Director of Public Services, Town of Medway
FROM: Kleinfelder
Prepared by: Michael Sanders, PE
Reviewed by: Michael Cunningham, PE
DATE : 3/14/2017
SUBJECT: **Water System Hydraulic Analysis for Timber Crest Estates Development**
CC: Kirsten Ryan, Kleinfelder; file

This memorandum has been prepared to summarize Kleinfelder's hydraulic analysis results for the proposed Timber Crest Estates Development in the Town of Medway.

1 PURPOSE

The purpose of this hydraulic analysis is to evaluate impacts to domestic and fire flow water availability in the vicinity of Timber Crest Estates due to the proposed construction of 157 single family homes.

2 SCOPE OF WORK

The scope of work consists of utilizing the Town's existing water distribution system hydraulic model to estimate the availability of water flow and water pressure in the vicinity of the development. Kleinfelder performed the hydraulic model simulations utilizing WaterGEMS hydraulic modeling software by Bentley Systems, Inc. The distribution system model was prepared by Tata & Howard in the early 2000's and last updated by Weston & Sampson in 2010.

Specifically, these are the five scope items:

1. Update the Town's existing water system model based on a list of recent water main projects provided by the Town. Create a peak hour demand scenario using industry standard multipliers for the full buildout of the proposed project.
2. Review and verify estimates for potable water demand and fire protection requirements for the proposed development based on sewer flow estimates and fire protection requirements provided by the developer's engineer. Kleinfelder will develop estimates using industry standard guidance if necessary.
3. Compare the available fire flow results of the Town's existing system model to fire flow test results provided by the developer. Improve calibration of the Town's existing system



model in the vicinity of the development using the provided fire flow results. Town to provide well and tank conditions during fire flow tests.

4. Perform computer hydraulic analyses, utilizing the Town's updated system model, to determine the availability of water (flow and pressure) at the location of the proposed development. Compare the computer hydraulic model results for water availability with the water demands (estimated potable water demand and fire protection requirements) of the proposed development.
5. Perform computer hydraulic analyses to determine if improvements to the Town's existing water distribution system are necessary to meet the required potable and fire protection water demands of the proposed building. Evaluate up to three (3) distribution system improvement options and document the results of the hydraulic analyses, and recommended improvements in a technical memorandum.

3 MODEL UPDATES

Kleinfelder reviewed two sets of water main replacement plans provided by the Town. One for fiscal year 2015 and one for fiscal year 2016 water main upgrades. The plans are both by Weston & Sampson and are dated March 2015 and March 2014 respectively. The upgrades include sections of Village Street, Adams Street, Winthrop Street and Highland Street. The plans indicate these pipelines were constructed of cement lined ductile iron pipe. Kleinfelder assumed a Hazen-Williams C-factor of 130 for these new pipes. Additionally, as described below, we added the proposed water mains for the Timber Crest Estates development.

4 CALIBRATION

Kleinfelder reviewed the results of five fire flow tests performed by John Hoadley and Sons Inc. on behalf of the developer on 12/1/2016. We compared the static pressure and available fire flow at each location with corresponding model results. Before calibration, the simulated available fire flow was an average of 16% lower across all 5 tests compared with actual test results. After calibration, simulated available fire flow was 3% higher on average for the 5 fire flow test sites. Kleinfelder deemed 3% average error as acceptable for the fire flow results based on industry standards for water system model calibration. During the calibration, Kleinfelder reduced the Hazen-Williams C-factor of the 6-inch water main in Holliston Street from 130 to 80. Additionally, we reduced all pipes with a C-factor of 150 to 140. The fire flow test at the hydrant near 99 Winthrop Street was noted to be connected to the 6-inch water main. However, the simulated fire flow shows that it is likely connected to the parallel 12-inch water main based on available fire flow in each main at this location.

On average, the modeled static pressures were less than 2% higher than the measured values. Kleinfelder deemed these results acceptable, so no adjustments were made to static pressures.

5 SCENARIOS EVALUATED

Kleinfelder evaluated several proposed water main layouts within the development based on a plan titled "Timber Crest Estates Water Connection Presentation" dated 12/5/2016 by Outback Engineers. This plan shows 8-inch diameter water mains forming a network in the proposed

development. The connections to the existing Town of Medway water system are shown at Winthrop Road, Fairway Lane, Holliston Street and Ohlson Circle. An option for an additional connection to the existing system is shown that would connect proposed Road F to the existing 6-inch water main in Fern Path. Another option is shown that would connect the east side of the development to the west side of the development between Road D and Road I. Kleinfelder was also asked to evaluate the impact of an upgraded Holliston Street water main from 6-inch diameter to 12-inch diameter from Lovering Street north to the Town Line. Figure 1 below highlights the “East-West” connection, the Fern Path connection and the Holliston Street water main upgrade.

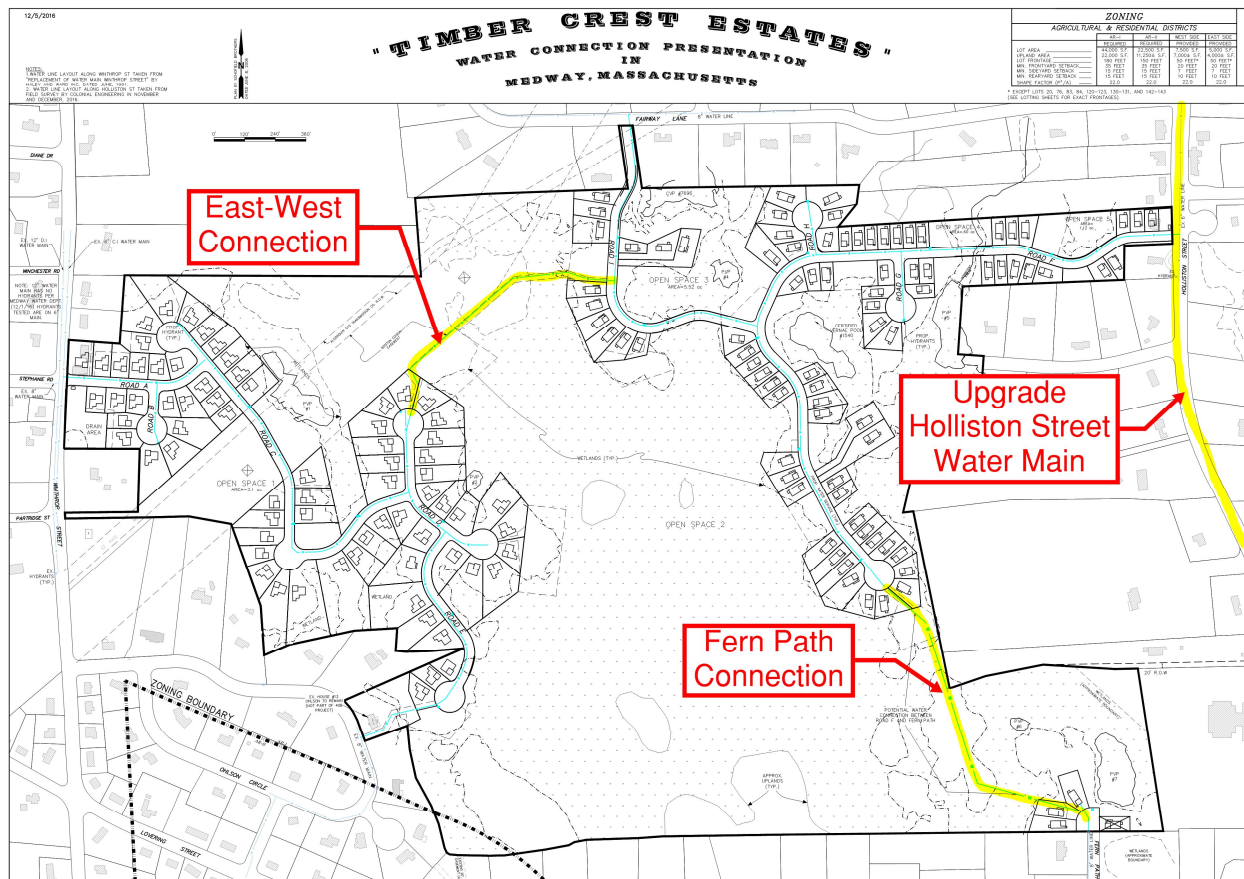


Figure 1: Improvement options presented by Outback Engineers for hydraulic analysis

Kleinfelder evaluated seven water system scenarios using the projected 2028 town-wide peak hour demand of 1,590 gallons per minute (gpm). This demand projection is from the report by Weston & Sampson dated January 2010 and titled Water System Master Plan. Based on a letter from Outback Engineers dated 12/6/2016, peak hour demand for the development scenarios was estimated to be 113,291 gallons per day or 79 gpm. This demand was apportioned evenly to all 14 new model nodes that represent the Timber Crest Development water main network. According to generally accepted practice, the Town's supply wells were not considered active during fire flow simulations. Additionally, Kleinfelder investigated the benefit of



upgrading 7,900 feet of water main in Holliston Street from 6-inch to 12-inch diameter from Lovering Street north to the Town line. The following list summarizes the seven scenarios:

- I. Existing conditions
- II. Existing conditions with Timber Crest Estates water mains, no East-West connection or Fern Path Connection
- III. Existing conditions with Timber Crest Estates water mains including the East-West connection excluding the Fern Path Connection
- IV. Existing conditions with Timber Crest Estates water mains excluding the East-West connection and including the Fern Path Connection
- V. Existing conditions with Timber Crest Estates water mains including both the East-West connection and Fern Path Connection
- VI. Existing conditions with Timber Crest Estates water mains, no East-West connection or Fern Path Connection. Upgraded Holliston Street Water Main from 6- to 12-inches.
- VII. Existing conditions with Timber Crest Estates water mains, including the East-West connection excluding the Fern Path Connection. Upgraded Holliston Street Water Main from 6- to 12-inches.

6 DOMESTIC PRESSURE ANALYSIS

Due to their elevations, several locations in the vicinity of the proposed development currently experience pressures lower than 35 psi. Some examples are Lovering Street, Field Road, Fairway Lane, Howe Street, Redgate Drive and Fern Path. The change in domestic water pressure in the surrounding neighborhood due to the projected peak hour water consumption at the proposed development is predicted to be less than 0.25 psi in the most affected area north of the proposed development. This represents an imperceptible change in pressure. The small change in pressure is attributed to the close proximity of the Lovering Street Water Tank which is about 1 mile away from the development. Additionally, like most water systems that provide both domestic service and fire protection service, the Town of Medway's water distribution system pipe network does not experience much head loss and associated pressure reduction even during periods of peak domestic demand. Therefore the main factors determining domestic pressure in the Town are the elevation of the homes, the level of the Town's storage tanks and the status of the supply pumps. These factors are not changed in the six scenarios presented in this analysis.

Based on elevations shown in the provided plan, the domestic pressure for the proposed development will be approximately 31 to 39 psi. The Massachusetts Department of Environmental Protection guideline for water distribution systems includes a minimum working pressure of 35 psi and a recommended pressure of 60 psi. Areas of this development above about 270 feet elevation will be at or below 35 psi. The simulated domestic water pressure is shown in Table 1 below. Furthermore, although not presented in Table 1, we verified that the addition of the Fern Street Connection to scenario VI will not improve domestic pressure for the reasons stated above.

Model Node Label/Location	MassDEP Guideline (psi)	Table 1: Domestic Water Pressure at selected model nodes (pounds per square inch) for various development scenarios						
		2030 Existing Conditions, (no Timber Crest)	2030 with Timber Crest w/o east-west connection or Fern Path connection	2030 Timber Crest w/ east-west connection, w/o Fern Path connection	2030 Timber Crest w/o east-west connection, w/ Fern Path connection	2030 Timber Crest w/ both east-west connection and Fern Path connection	2030 with Timber Crest w/ Holliston St. 6" to 12", w/o Fern or East-West Conns.	2030 with Timber Crest w/ Holliston St. 6" to 12", w/o Fern, w/ East-West Conn.
894 (Woodland Road dead-end)	35	38.9	38.7	38.8	38.8	38.9	38.9	38.9
J170 (Holliston Street south of Sun Valley Drive)	35	32.4*	32.3*	32.4*	32.4*	32.4*	32.4*	32.4*
J-12 (eastern side of Ohlson Circle)	35	39.0	39.0	38.9	39.0	38.9	39.0	38.9
882 (Cider Mill Road dead-end)	35	33.4*	33.3*	33.4*	33.4*	33.4*	33.4*	33.5*
872 (Fairway Lane at Algonquin Avenue)	35	33.2*	33.1*	33.2*	33.2*	33.3*	33.2*	33.3*
J-19 (Road D and Road C)	35	N/A	33.3*	33.3*	33.3*	33.3*	33.3*	33.3*
J-30 (south end of Road F)	35	N/A	35.7	35.8	35.8	35.9	35.8	35.9

*Domestic pressure does not meet Massachusetts DEP Guidelines



7 FIRE FLOW ANALYSIS

In addition to meeting domestic needs, the Town of Medway's water distribution system must supply fire flow to the proposed development.

Kleinfelder estimated the Needed Fire Flow for the new development. According to the plan titled "Timber Crest Estates Water Connection Presentation" dated 12/5/2016, the spacing of buildings will vary from about 20 feet to about 60 feet. The buildings are described in a letter from Outback Engineers dated 12/6/2016 to be single family homes. Kleinfelder reviewed table 1-6 in American Water Works Association (AWWA) Manual M31 Distribution System Requirements for Fire Protection, fourth edition. Excerpted below, this table shows a needed fire flow for single family homes spaced at 11 to 30 feet to be 1,000 gpm. For homes spaced 31 to 100 feet, the needed fire flow is 750 gpm. Since most spacing in the development appears to be between 11 and 30 feet, Kleinfelder used 1,000 gpm as the needed fire flow for the entire development. For existing areas of the Town, Kleinfelder estimated the distance between buildings based on aerial imagery.

Table 2: Needed fire flow for one-and two-family dwellings

Distance between Buildings (ft)	Needed Fire Flow (gal/min)
More than 100	500
31 to 100	750
11 to 30	1,000
Less than 11	1,400

In order for a development to be adequately protected, the available fire flow must be greater than the needed fire flow. As shown above, the needed fire flow for Timber Crest Estates is estimated to be 1,000 gpm. Additionally, the domestic demands of the new development must not reduce the available fire flow below the needed fire flow for the surrounding areas of the Town. Below is a table of locations in the northeast section of Medway that are most impacted by the new development. The location of each node is shown in Figure 2 below. The estimated needed fire flow is shown alongside the simulated available fire flow for the six scenarios in Table 3.

Figure 2: Fire flow node location plan (Not to Scale)

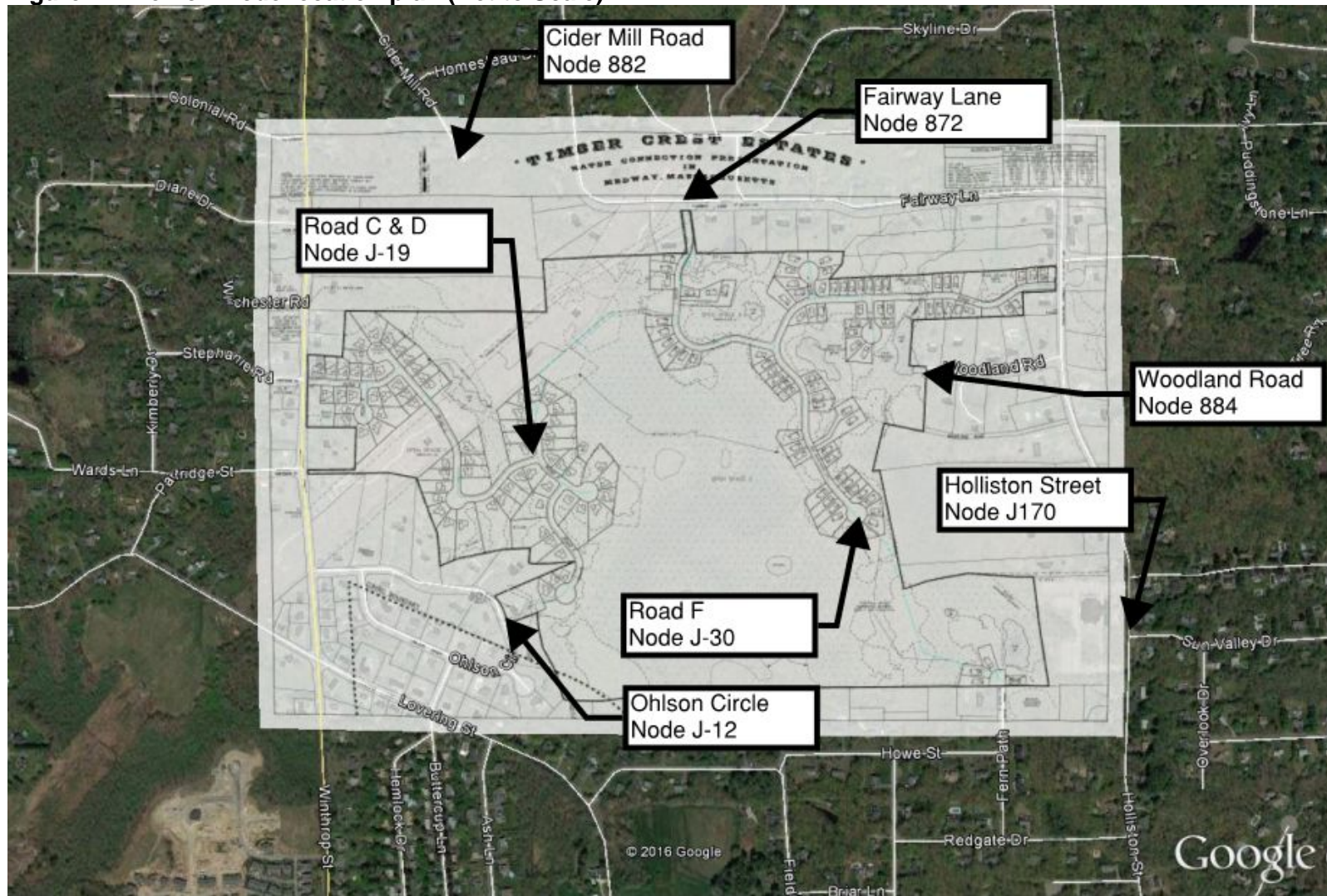




Table 3: Needed and Available fire flow at selected model nodes

Model Node Label/Location	Estimated Needed Fire Flow (gal/min)	Available fire flow at selected model nodes (gal/min) for various development scenarios						
		2030 Existing Conditions, (no Timber Crest)	2030 with Timber Crest w/o east-west connection or Fern Path connection	2030 Timber Crest w/ east-west connection, w/o Fern Path connection	2030 Timber Crest w/o east-west connection, w/ Fern Path connection	2030 Timber Crest w/ both east-west connection and Fern Path connection	2030 with Timber Crest w/ Holliston St. 6" to 12", w/o Fern or East-West Conns.	2030 with Timber Crest w/ Holliston St. 6" to 12", w/o Fern, w/ East-West Conn.
894 (Woodland Road dead-end)	500	610	680	770	770	800	1,439	1,525
J170 (Holliston Street south of Sun Valley Drive)	750	870	860	885	880	890	2,610	2,995
J-12 (eastern side of Ohlson Circle)	750	2,330	2,370	2,730	2,370	2,775	2,495	3,005
882 (Cider Mill Road dead-end)	750	800	790	900	895	925	940	980
872 (Fairway Lane at Algonquin Avenue)	750	940	900	1,425	1,340	1,640	1,745	2,135
J-19 (Road D and Road C)	1,000	N/A	1,490	1,865	1,495	1,975	1,530	2,150
J-30 (south end of Road F)	1,000	N/A	710*	895*	1,575	1,726	945*	1,033

*Available Fire Flow does not meet Needed Fire Flow



Table 3 above shows that available fire flow within the development is strongest under the scenario that includes both the east-west connection and the Fern Path connection; whereas; upgrading the water main in Holliston Street to 12-inch diameter pipe provides a major fire flow improvement to neighborhoods around the proposed development. The scenarios with the lowest available fire flow are existing conditions and the development scenario with neither the east-west connection nor the Fern Path connection.

If neither the east-west connection nor the Fern Path connection are constructed, the lowest available fire flow in the new development will be the end of Road F closest to Fern Path with 710 gpm. As described above, the needed fire flow for this type of development is 1,000 gpm. If the East-West connection and the Holliston Street upgrade are implemented, the recommended fire flow requirements would be met. Therefore, Scenarios IV, V and VII as described in Section 3 meet the recommended fire flow requirements:

- IV. Existing conditions with Timber Crest Estates water mains excluding the East-West connection and including the Fern Path Connection
- V. Existing conditions with Timber Crest Estates water mains including both the East-West connection and Fern Path Connection
- VII. Existing conditions with Timber Crest Estates water mains, including the East-West connection excluding the Fern Path Connection, and upgraded Holliston Street Water Main from 6- to 12-inches.

The addition of the Timber Crest development does not reduce the available fire flows in the surrounding neighborhood below the estimated needed fire flows. As shown in Table 2, the available fire flow increases at some locations and decreases at others compared to the existing conditions. The largest reduction is at node 872 (Fairway Lane at Algonquin Avenue) where the available fire flow is reduced from 940 to 900 gpm. The needed fire flow at this location is estimated to be 750 gpm. With the Fern Path connection, the available fire flow at node 872 (Fairway Lane at Algonquin Avenue) is estimated to increase to 1,340 gpm. Under Scenario VII, the available fire flow is estimated to increase to 2,135 gpm.

If neither the east-west connection nor the Fern Path connection are constructed, but the water main on Holliston Street is upgraded from 6-inch to 12-inch, the available fire flow to the development and surrounding neighborhood will be increased. However, at Road F closest to Fern Path available fire flow will be 945 gpm which does not meet the needed fire flow of 1,000 gpm.

8 RECOMMENDATIONS

Kleinfelder recommends that the development include the improvements outlined in Scenario IV, V or VII as described in Section 3. That is, the Fern Path connection or the combination of the East-West connection and the upgraded Holliston Street water main to allow the Town's water system to deliver adequate fire flow to meet the site's fire flow requirements. Additionally,



Kleinfelder recommends that the developer mitigate the anticipated low domestic water pressures in this area. For example, installing a booster pump station in each home or a single, larger system to serve the entire development will increase system pressure above minimum standards. A single, larger pump station will have long-term operation and maintenance requirements and the Town would not take ownership of such a system. Therefore, the individual booster pumps appear to be the only viable solution to address low pressure.