# Glenwood DWSMA Groundwater Protection Rule Summary

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## Introduction

This document summarizes the Minnesota Department of Agriculture's (MDA) current understanding of the Glenwood Drinking Water Supply Management Area (DWSMA), public well nitrate-nitrogen levels, and nitrogen management information. Also included is a summary of the MDA's analysis of nitrogen loss below cropland within this DWSMA. This summary provides the detail the MDA considered to determine whether the proposed list of nitrogen fertilizer best management practices (BMPs) and Alternative Management Tools (AMTs) will be protective of groundwater.

## DWSMA and Public Well Nitrate-Nitrogen Data

The DWSMA boundary defined by the Minnesota Department of Health (MDH) for the City of Glenwood public wells includes 1,003 acres. The MDH defines the groundwater below this DWSMA as moderate vulnerability. Of the 1,003 acres in the DWSMA, 416 acres meet the definition of cropland in the Groundwater Protection Rule (GPR). The GPR applies to the 416 acres of cropland within this DWSMA.

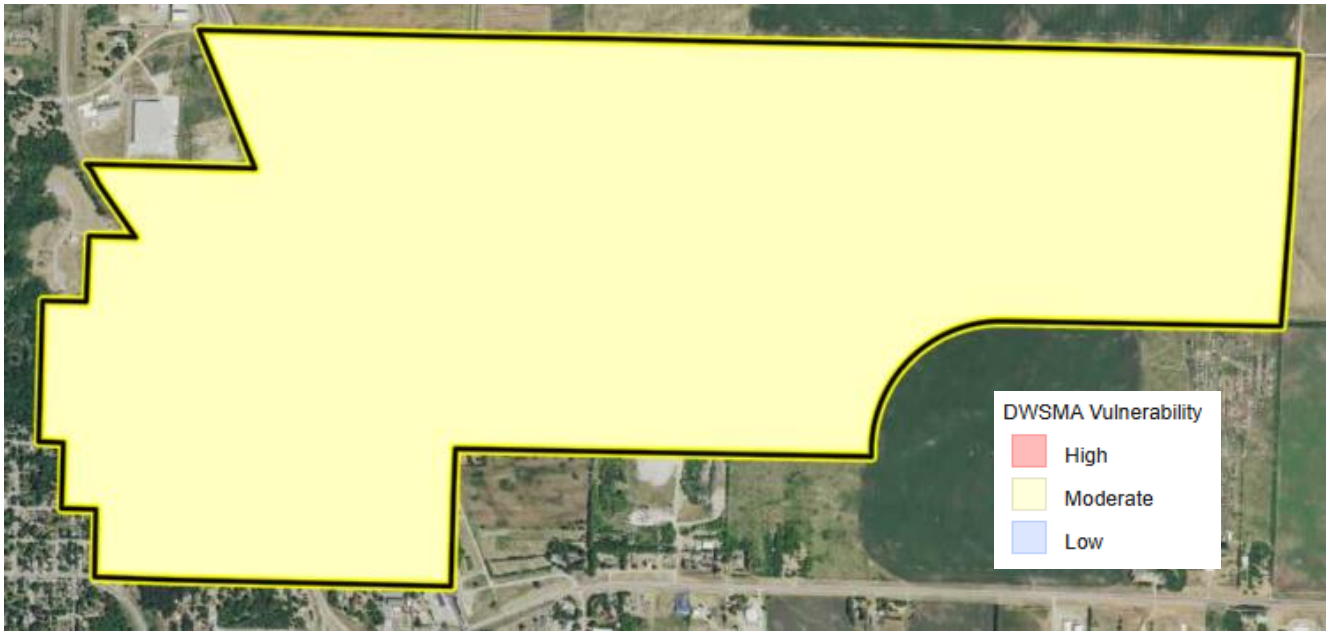


**Figure 1. Glenwood DWSMA Vulnerability Designated by the Minnesota Department of Health.**

The MDA relies on the water quality data provided by the MDH to evaluate nitrate-nitrogen levels in the public water supply. Nitrate-nitrogen levels have exceeded 8 mg/L in one of the Glenwood public wells within the past ten years (Figure 2).

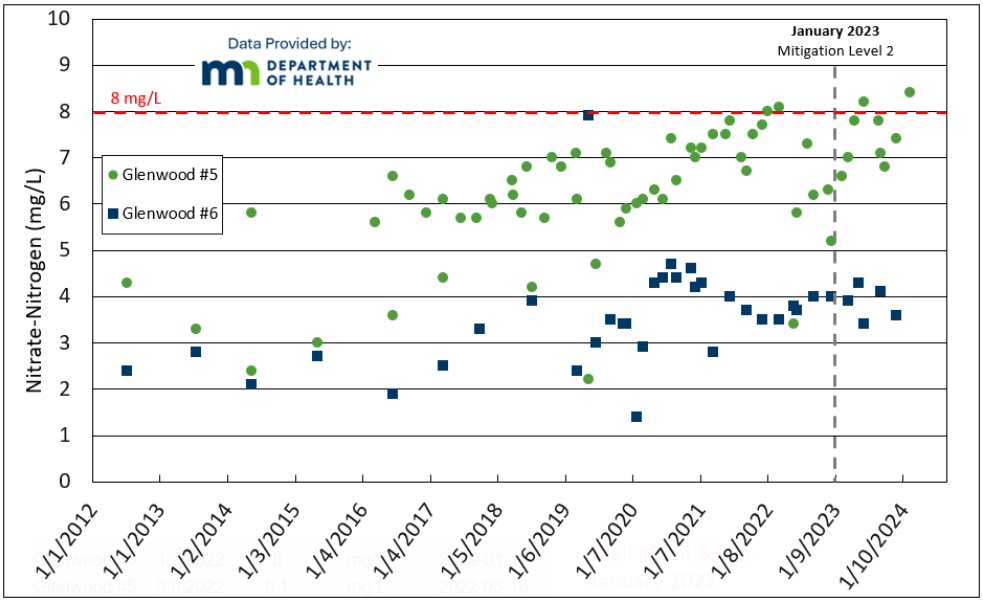


**Figure 2. Glenwood public well nitrate data through February 2024. See Table 9 for specific well information.**

**Table 1. City of Glenwood public well information.**

| Local Well ID | MDH Status | Casing Diameter (in) | Casing Depth (ft) | Well Depth (ft) | Date Constructed |
|---|---|---|---|---|---|
| Well #5 | Primary | 12 | 80 | 90 | 1965 |
| Well #6 | Primary | 12 | 80 | 108 | 1978 |

## DWSMA Land Use and Potential Nitrate-Nitrogen Point Source Consideration

The MDA conducted a detailed review of potential contaminant sources to determine whether a point source of nitrogen could be the cause of the public well exceeding the criteria for mitigation level designation (Minnesota Statute 1573.0040, Subp. 3, C). In the Glenwood DWSMA, the MDA review did not identify a point source for nitrate-nitrogen. With nitrate levels exceeding 8.0 mg/L within the past ten years and without a point source contribution, this DWSMA was designated at Mitigation Level 2 under Part 2 of the Groundwater Protection Rule in January 2023 (Minnesota Statute 1573.0040, Subp. 7, C, 2).

Part 2 of the Groundwater Protection Rule responds to DWSMAs which have elevated nitrate. The goal is to take action to reduce nitrate in groundwater before a public well exceeds the health standard for nitrate, 10 mg/L. For DWSMAs, like Glenwood designated at Level 2, the MDA works with a local advisory team (LAT) including local farmers, agronomists, and others to get input on agricultural practices that can reduce nitrate levels in groundwater.

The Groundwater Protection Rule defines cropland as land used primarily for the production or harvest of annual or perennial field, forage, food, fiber, or energy crops including pasture but excluding forestland. The evaluation of BMP adoption, to determine if a mitigation level change is needed, excludes soybean acres (Minnesota Statute 1573.0040, Subp. 7, A).

A review of the publicly available USDA Cropland Data Layer (hosted on Crop Scape, nass.usda.gov/Research_and_Science/Cropland/Release/index.php) in the Glenwood DWSMA shows that 41% of the landcover is cropland (Figure 3).

In addition to review of cropping history, the MDA also surveyed agronomists and farmers to understand the nitrogen fertilizer management practices used in the Glenwood area. The MDA was able to obtain farming information for most of the cropland acres across the DWSMA. Having current and accurate nitrogen fertilizer management data is critical to the discussion of protective agricultural management practices (i.e. BMPs and AMTs) appropriate for this DWSMA. With computer modeling tools, the MDA compares nitrogen leaching loss below current nitrogen fertilizer management and under management changes proposed to protect groundwater. The farming practice information collected includes crop planting, harvest, tillage, and nitrogen fertilizer use data.

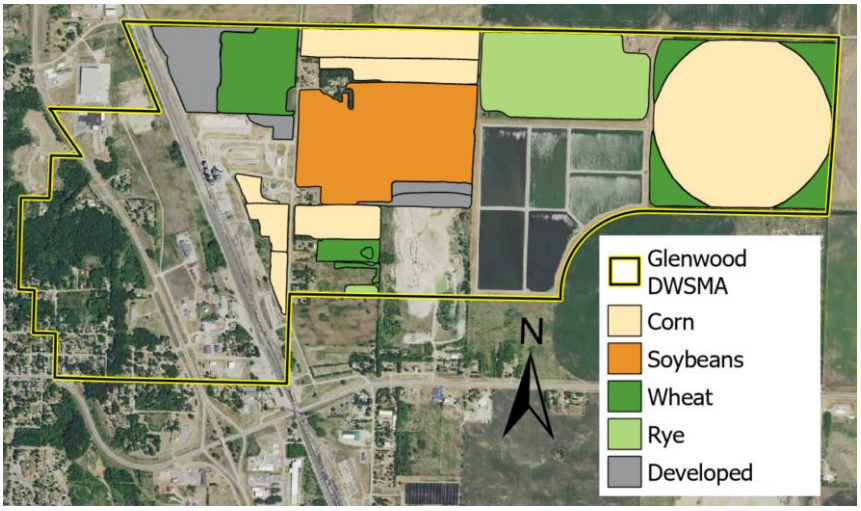


**Figure 3. 2022 cropland cover in the Glenwood DWSMA based on the USDA Cropland Data Layer. See Table 3 for specific 2022 cropland cover information**

Farmers within this DWSMA use both commercial nitrogen and manure to fertilize corn. Table 2 shows the cropland rotations present within the DWSMA.

**Table 2. Glenwood DWSMA Cropland Rotations**

| Crop Rotation (2013-2022) | Acres | % of Cropland (416 acres total) |
|---|---|---|
| Corn-Soybean | 289 | 70% |
| Wheat-Rye-Soybean-Canola | 67 | 16% |
| Wheat-Soybean | 31 | 7% |
| Wheat-Canola | 29 | 7% |

Due to the small number of operators farming within this DWSMA, more detailed farming practice information cannot be included in this document. Minnesota's statute on Agricultural Data (Minnesota Statute 13.643 Subd. 7) protects the identities and location of producers who are cooperating with the MDA in an assessment of farm practices. If farm practice information could identify an individual, it is considered private information and cannot be shared by the MDA.

Based on the detailed nitrogen fertilizer use information the MDA was able to collect within this DWSMA, nitrogen rates are within University of Minnesota guidelines, nitrogen applications are split, all nitrogen sources are accounted for, and nitrogen credits from previous legume crops and manure are taken. The BMPs recommended by the University of MN for the cropping rotations and soil types present within this DWSMA are currently being used.

Within the Glenwood DWSMA the crops grown in 2022 included corn, soybeans, spring wheat, and rye (Table 3). Canola is not shown in the 2022 crop year, but this is another important crop grown in this DWSMA.

**Table 3. 2022 Glenwood DWSMA Cropland Cover**

| Crop Type | Acres | % of Cropland (416 acres total) |
|---|---|---|
| Corn | 190 | 46% |
| Soybean | 91 | 22% |
| Rye | 69 | 17% |
| Spring wheat | 66 | 16% |

The MDA has also reviewed the USDA Cropland Data Layer over the past ten years in Glenwood's DWSMA. During this time, corn and soybeans have been the primary crops grown. Spring wheat and rye make up an average of 19% of the cropland (Table 4). Canola has been grown in three of the ten years (Table 4 and Figure 4) and accounts for 21-23% of the DWSMA cropland when it is grown.

**Table 4. Glenwood DWSMA cropland crop history 2013-2022.**

| Year | Corn Acres | Corn % of Cropland | Soybean Acres | Soybean % of Cropland | Spring Wheat Acres | Spring Wheat % of Cropland | Rye Acres | Rye % of Cropland | Canola Acres | Canola % of Cropland | Perennial Crops (Hay & Alfalfa) Acres | Perennial Crops (Hay & Alfalfa) % of Cropland |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2013 | 245 | 54% | 104 | 23% | 2 | 0% | | | 95 | 21% | 7 | 2% |
| 2014 | 72 | 16% | 222 | 49% | 151 | 33% | | | | | 7 | 2% |
| 2015 | 222 | 52% | 103 | 24% | 98 | 23% | | | | | 7 | 2% |
| 2016 | 197 | 44% | 124 | 28% | 32 | 7% | | | 95 | 21% | | |
| 2017 | 102 | 24% | 228 | 54% | 96 | 23% | | | | | | |
| 2018 | 197 | 46% | 102 | 24% | 31 | 7% | | | 96 | 23% | | |
| 2019 | 96 | 23% | 228 | 54% | 96 | 23% | | | | | | |
| 2020 | 225 | 53% | 97 | 23% | 98 | 23% | | | | | | |
| 2021 | 91 | 22% | 256 | 61% | 2 | 0% | 67 | 16% | | | | |
| 2022 | 190 | 46% | 91 | 22% | 66 | 16% | 69 | 17% | | | | |

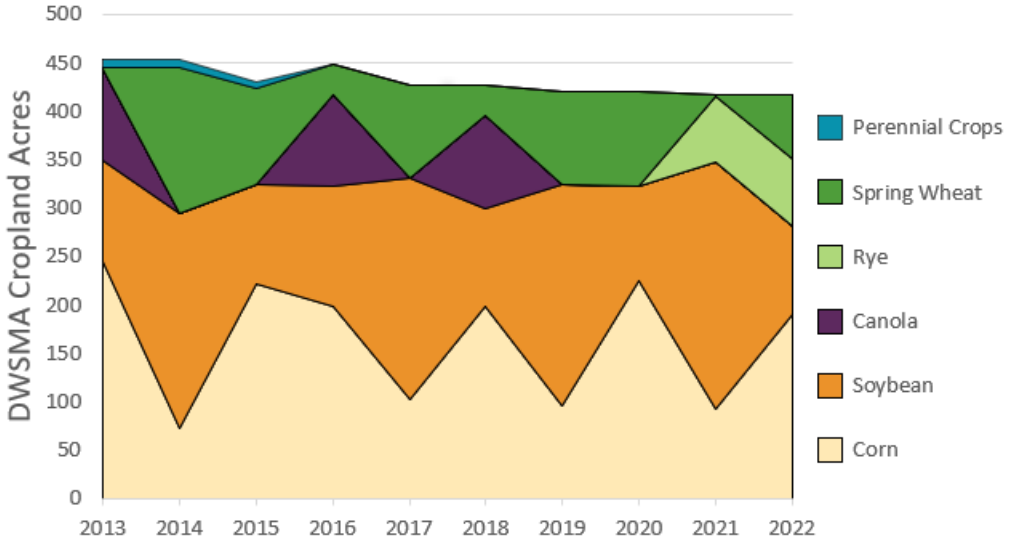


**Figure 3. Glenwood DWSMA cropland crop history graph 2013-2022. See Table 4 for more information.**

## DWSMA Nitrate-Nitrogen Loss Below Cropland

Using a crop and soil computer simulation called the Environmental Policy Integrated Climate (EPIC) model (https://epicapex.tamu.edu/epic/), the MDA has estimated the nitrogen loss below the root zone in the Glenwood DWSMA comparing the nitrogen management practices used in the recent past with the nitrogen loss below alternative practices. The table below shows the crop rotations modeled within the Glenwood DWSMA (Table 5).

With all nitrogen fertilizer BMPs applicable to the crop and soils present already in use within the DWSMA, MDA modeling considered additional practices (Table 6) and Alternative Management Tools (Table 7) that go above and beyond BMPs to explore options that can further reduce nitrogen loss below the root zone. If AMTs were adopted, the model estimates that nitrogen leaching below the rootzone within this DWSMA could be reduced by the percentages shown in Tables 6 and 7. Working with local farmers this list will be promoted and when possible, funding will be identified to support adoption of these practices. Table 8 illustrates an AMT voluntarily adopted in the DWSMA to protect the Glenwood drinking water supply. The model estimates that nitrogen leaching below the cropland rootzone is reduced by 7% with this AMT implemented.

**Table 5. Glenwood DWSMA cropland rotations that MDA modeling estimated nitrate-nitrogen loss below following current nitrogen management practices.**

| Crop Rotation | Acres |
|---|---|
| Corn-Soybean (irrigated) | 120 |
| Corn-Soybean (dryland) | 170 |
| Wheat-Soybean | 31 |
| Wheat Canola | 29 |
| Wheat-Rye-Soybean-Canola | 67 |

**Table 6. Glenwood DWSMA modeled nitrogen loss below additional practices considered by the Glenwood LAT.**

| Management Change | Additional Acres within DWSMA | Nitrogen Loss Reduction | Notes |
|---|---|---|---|
| Replace fall manure with spring preplant urea | 120 | 14.4% | Applying nitrogen in the spring closer to the time when a growing crop can take up that nitrogen reduces the risk of nitrogen loss below the crop root zone. Only a portion of the nitrogen in manure is readily available to the plant at application. A higher rate of nitrogen is applied in manure form to meet the plant needs. Nitrogen in urea is readily available to the plant and can be applied at a lower rate to meet the plant need. |

**Table 7. Glenwood DWSMA modeled nitrogen loss below AMTs considered by the Glenwood LAT.**

| Management Change | Additional Acres within DWSMA | Nitrogen Loss Reduction | Notes |
|---|---|---|---|
| C-AAA in place of C-S on irrigated ground | 120 | 14% | Convert 120 acres of irrigated corn-soybean to a corn-alfalfa rotation (C-A-A-A). |
| C-AAA in place of C-S on dryland ground | 120 | 20% | Convert 120 acres of dryland corn-soybean to a corn-alfalfa rotation (C-A-A-A). |
| Cover crop after SB on dryland ground in a C-S rotation | 120 | 8% | This is an average of 60 acres of cover crop planted annually. |

**Table 8. Glenwood DWSMA modeled nitrogen loss below AMTs adopted in the Glenwood DWSMA.**

| Management Change | Additional Acres within DWSMA | Nitrogen Loss Reduction | Notes |
|---|---|---|---|
| Cover crop after corn on irrigated ground in a C-S rotation | 120 | 7% | This is an average of 60 acres of cover crop planted annually. |

## MDA Recommended Nitrogen Fertilizer Best Management Practices for the Glenwood DWSMA

In consultation with the Local Advisory Team that includes farmers and agronomists managing cropland within the DWSMA, the MDA has developed the following list of BMPs to protect groundwater. A more detailed list of these BMPs is available on the Glenwood DWSMA webpage (mda.state.mn.us/glenwood-dwsma).

- Apply nitrogen to dryland corn in a corn-corn rotation at or below the 0.125 Maximum Return to Nitrogen (MRTN) in the University of Minnesota's nitrogen fertilizer application guidelines.
- Apply nitrogen to dryland corn in a corn-soybean rotation at or below the 0.125 MRTN in the University of Minnesota's nitrogen fertilizer application guidelines.
- Apply nitrogen to irrigated corn in a corn-soybean rotation at or below the 0.10 MRTN in the University of Minnesota's nitrogen fertilizer application guidelines.
- Apply nitrogen to irrigated corn in a corn-corn rotation at or below the 0.10 MRTN in the University of Minnesota's nitrogen fertilizer application guidelines.
- For all other crops grown within the DWSMA nitrogen rates must follow the current University of Minnesota guidance applicable to that crop.
- Account for all nitrogen sources when calculating nitrogen rate.
- Take appropriate credits for previous legume crops and manure used in the crop rotation.
- Split applications of nitrogen fertilizer on coarse textured soils.
- On coarse textured soils use nitrogen stabilizer on labeled crops when applying at early sidedress.

The MDA will conduct an evaluation in this Level 2 DWSMA to determine whether these nitrogen fertilizer BMPs have been implemented on 80% of the cropland, excluding soybeans. The evaluation will occur no sooner than three growing seasons after the BMP list is published.

## Conclusion

In the Glenwood DWSMA the MDA has reviewed the cropping history, surveyed nitrogen management practices, modeled nitrogen loading estimates below existing nitrogen fertilizer management practice and alternative practices.

Based on our farmer and fertilizer dealer survey the current University of Minnesota nitrogen fertilizer BMPs are being followed on all cropland acres within the DWSMA. University of Minnesota nitrogen rate guidance is being followed for all crops, corn nitrogen rates are below the 0.125 MRTN for dryland corn and 0.10 MRTN for irrigated corn, all nitrogen sources are considered, nitrogen applications to corn are split, and nitrogen credits from legumes and manure are counted.

Modeling of nitrogen loss below additional practices and Alternative Management Tools within this DWSMA illustrate options that can further reduce nitrogen loss below the crop root zone. These options were developed in consultation with the LAT. Fall cover crop has been established following corn on a portion of the cropland resulting in an estimated 7% reduction in nitrogen loss. Specific acres have not been identified for the establishment of other alternative practices, but the LAT acknowledges the additional groundwater protection that these could provide if adopted. The next steps within this DWSMA are to review these practices with individual landowners and explore possible funding opportunities to establish these practices.

Based on the understanding and information provided above, the MDA believes that the recommended nitrogen management practices within the Glenwood DWSMA are appropriate and that over the long-term the continued use of these practices along with the adoption of Alternative Management Tools and additional practices identified will reduce nitrate-nitrogen loss below cropland. Promotion and funding to support the establishment of alternative practices within the Glenwood DWSMA will be a priority.

## Supplemental Data

The following table is supplemental information for the "Glenwood DWSMA Groundwater Protection Rule Summary". The data included below is presented as a graph (Figure 2) in the summary document.

**Table 9. Nitrate-nitrogen levels within the Glenwood public well that has exceeded 8 mg/L within the past ten years.**

| Well Number | Collection Date | Nitrogen Test Levels in mg/L |
|---|---|---|
| 5 | 5/13/2014 | 5.8 |
| 5 | 5/13/2014 | 2.4 |
| 5 | 5/6/2015 | 3 |
| 5 | 3/14/2016 | 5.6 |
| 5 | 6/14/2016 | 3.6 |
| 5 | 6/14/2016 | 6.6 |
| 5 | 9/13/2016 | 6.2 |
| 5 | 12/12/2016 | 5.8 |
| 5 | 3/15/2017 | 6.1 |
| 5 | 3/17/2017 | 4.4 |
| 5 | 6/20/2017 | 5.7 |
| 5 | 9/13/2017 | 5.7 |
| 5 | 11/27/2017 | 6.1 |
| 5 | 12/4/2017 | 6 |
| 5 | 3/22/2018 | 6.5 |
| 5 | 3/28/2018 | 6.2 |
| 5 | 5/15/2018 | 5.8 |
| 5 | 6/11/2018 | 6.8 |
| 5 | 7/11/2018 | 4.2 |
| 5 | 9/17/2018 | 5.7 |
| 5 | 10/25/2018 | 7 |
| 5 | 12/17/2018 | 6.8 |
| 5 | 3/4/2019 | 7.1 |
| 5 | 3/12/2019 | 6.1 |
| 5 | 5/14/2019 | 2.2 |
| 5 | 6/19/2019 | 4.7 |
| 5 | 8/14/2019 | 7.1 |
| 5 | 9/10/2019 | 6.9 |
| 5 | 10/30/2019 | 5.6 |
| 5 | 12/2/2019 | 5.9 |
| 5 | 1/29/2020 | 6 |
| 5 | 3/4/2020 | 6.1 |
| 5 | 5/6/2020 | 6.3 |
| 5 | 6/16/2020 | 6.1 |
| 5 | 8/4/2020 | 7.4 |
| 5 | 9/2/2020 | 6.5 |
| 5 | 11/17/2020 | 7.2 |
| 5 | 12/8/2020 | 7 |
| 5 | 1/12/2021 | 7.2 |
| 5 | 3/17/2021 | 7.5 |
| 5 | 5/24/2021 | 7.5 |
| 5 | 6/15/2021 | 7.8 |
| 5 | 8/17/2021 | 7 |
| 5 | 9/14/2021 | 6.7 |
| 5 | 10/20/2021 | 7.5 |
| 5 | 12/6/2021 | 7.7 |
| 5 | 1/5/2022 | 8 |
| 5 | 3/9/2022 | 8.1 |
| 5 | 5/25/2022 | 3.4 |
| 5 | 6/15/2022 | 5.8 |
| 5 | 8/9/2022 | 7.3 |
| 5 | 9/13/2022 | 6.2 |
| 5 | 11/30/2022 | 6.3 |
| 5 | 12/19/2022 | 5.2 |
| 5 | 2/15/2023 | 6.6 |
| 5 | 3/16/2023 | 7 |
| 5 | 4/24/2023 | 7.8 |
| 5 | 6/13/2023 | 8.2 |
| 5 | 8/28/2023 | 7.8 |
| 5 | 9/13/2023 | 7.1 |
| 5 | 10/4/2023 | 6.8 |
| 5 | 12/6/2023 | 7.4 |
| 5 | 2/14/2024 | 8.4 |
| 6 | 5/13/2014 | 2.1 |
| 6 | 5/13/2014 | 2.1 |
| 6 | 5/6/2015 | 2.7 |
| 6 | 6/14/2016 | 1.9 |
| 6 | 3/17/2017 | 2.5 |
| 6 | 9/28/2017 | 3.3 |
| 6 | 7/11/2018 | 3.9 |
| 6 | 3/12/2019 | 2.4 |
| 6 | 5/14/2019 | 7.9 |
| 6 | 6/19/2019 | 3 |
| 6 | 9/10/2019 | 3.5 |
| 6 | 11/18/2019 | 3.4 |
| 6 | 12/2/2019 | 3.4 |
| 6 | 1/29/2020 | 1.4 |
| 6 | 3/4/2020 | 2.9 |
| 6 | 5/6/2020 | 4.3 |
| 6 | 6/16/2020 | 4.4 |
| 6 | 8/4/2020 | 4.7 |
| 6 | 9/2/2020 | 4.4 |
| 6 | 11/17/2020 | 4.6 |
| 6 | 12/8/2020 | 4.2 |
| 6 | 1/12/2021 | 4.3 |
| 6 | 3/17/2021 | 2.8 |
| 6 | 6/15/2021 | 4 |
| 6 | 9/14/2021 | 3.7 |
| 6 | 12/6/2021 | 3.5 |
| 6 | 3/9/2022 | 3.5 |
| 6 | 5/25/2022 | 3.8 |
| 6 | 6/15/2022 | 3.7 |
| 6 | 9/13/2022 | 4 |
| 6 | 12/19/2022 | 4 |
| 6 | 3/16/2023 | 3.9 |
| 6 | 5/16/2023 | 4.3 |
| 6 | 6/13/2023 | 3.4 |
| 6 | 9/13/2023 | 4.1 |
| 6 | 12/6/2023 | 3.6 |