Manitoba

Memorandum

DATE: February 4th, 2019

TO: Eugene Kozera
Director
Hydrologic Forecasting & Water Management
Manitoba Infrastructure

FROM: Chris Propp, P.Eng.
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Hydrologic Operations
Manitoba Infrastructure

SUBJECT: Development of Operating Rules for Lake Manitoba and Lake St. Martin Outlet Channels with Recommended Revisions

This memorandum summarizes the recommendations made by the Lake Manitoba and Lake St. Martin Outlet Channels Operating Guidelines Technical Committee. The Committee was formed to develop the operating guidelines for the proposed Lake Manitoba and Lake St. Martin Outlet Channels in 2016. The Committee was composed of Chris Propp (MI), Eugene Kozera (MI), Ron Richardson (MI), Rick Bowering (MI), Eric Blais (AECOM), and Rick Carson (KGS). The proposed operating guidelines developed by the Committee for the Lake Manitoba and Lake St. Martin Outlet Channels are summarized in Appendix A.

At the onset of the project the Committee decided that the principles of Lake Manitoba and Lake St. Martin regulation laid out by the 2003 Lake Manitoba Regulation Review Advisory Committee and the 2013 Lake Manitoba, Lake St. Martin Regulation Review Committee would be used as the starting point for the development of the operating rules for the proposed Outlet Channels. The Committee agreed that the lake regulation ranges recommended by the 2003 and 2013 committees should not be changed and agreed with the recommendation to minimize outflow adjustments once the lakes are within their respective regulation ranges.

Included in this memo are recommended revisions to the operating guidelines based on further review of the hydrologic modelling and recent discussions with the Engineering Service Providers responsible for the preliminary design of the Outlet Channels. These revisions are highlighted in bold and are noted as revisions. The revisions to the operating guidelines have minimal impact to the hydrologic regime when compared to the impact of the guidelines developed in 2016.

Guidelines and Regulation Ranges Recommended by 2003 and 2013 Committees

The regulation ranges of 810.5 ft – 812.5 ft for Lake Manitoba and 797 ft – 800 ft for Lake St. Martin proposed by the 2003 review committee were accepted for the proposed operating guidelines. The Lake Manitoba regulation range was based on input from cottagers, residents, ranchers, and wildlife interests around Lake Manitoba. The residents and cottagers at Twin Lakes Beach and Delta Beach and the ranchers around the lake identified 811.5 ft as the desirable water level. Residents and cottagers north of Twin Lake and Delta Beach prefer a target range of 812.2 ft. Wildlife interests stated that the narrow range of regulation from 1961-2003 had degraded the marshland around the lake. They stated that a 3 feet fluctuation in lake level would likely restore the health of the marshes over time.

The regulation range and operating guidelines recommended by the 2003 committee for Lake

Manitoba were also intended to reduce negative impacts on Lake St. Martin. Attempts to maintain Lake Manitoba within a narrow range from 1961-2003 increased the frequency and severity of flood and drought periods on Lake St. Martin. First Nations communities around Lake St. Martin stated that the desirable range on Lake St. Martin is 797 ft – 800 ft and that the minimum flows in the Fairford and Dauphin Rivers should be 1100 cfs.

In response to the majority of the interested parties, the 2003 Committee recommended operating guidelines that would have Lake Manitoba water levels managed so that the levels at the high end of the range would be similar to those reached during the period of regulation and low water levels similar to those reached under natural conditions before regulation. The recommended guidelines would also reduce the wide fluctuations in flow and water level that had been transferred to downstream water bodies, which had created severe problems for First Nations, downstream wildlife, fisheries, and tourist operators.

The Lake Manitoba and Lake St. Martin regulation guidelines for the Fairford River Water Control Structure that were recommended by the 2003 Committee and later amended by the 2013 Committee are as follows:

a) The desired regulation range on Lake Manitoba is 812.5 ft to 810.5 ft. The desired regulation range on Lake St. Martin is 797.0 ft to 800.0 ft.

b) During recovery from flood conditions on Lake Manitoba, the Fairford River Water Control Structure is kept wide open until Lake Manitoba recedes to the middle of the desired regulation range after which it should be cut back to achieve normal (natural) outflow (50-60% capacity)

c) During recovery from drought, the Fairford River Water Control Structure is kept at 800 cfs until Lake Manitoba levels increase to middle of the desired regulation range after which point the structure will be operated to achieve normal outflow (50-60% capacity)

d) Under normal operating conditions, once outflow reaches normal, there are no further stop-log adjustments, as long as Lake Manitoba remains within the desired regulation range.

e) Any variances in the lake levels outside of the desired regulation range shall be shared between Lake Manitoba and Lake St. Martin insofar as this may be reasonably possible.

f) The minimum flow on the Fairford River should be 800 cfs with a desirable minimum flow of 1,000 cfs as often as possible.

These guidelines are the currently accepted operating guidelines for the Fairford River Water Control Structure.

Water Level Simulation

A Lake Manitoba/Lake St. Martin Water Balance Model developed in MS Excel by Mr. Rick Bowering was used to evaluate the impacts of the proposed operating guidelines for the outlet channels. Historical daily inflows to Lake Manitoba were estimated for a 103 year period (1915-2017) based on recorded flow and water level data, a stage-storage curve for Lake Manitoba, and precipitation and evaporation data from Environment Canada. The inflows were then routed through the model using the Continuity Equation to simulate levels and outflows on Lake Manitoba and Lake St. Martin for the period of 1915-2017 under different operating regimes.

The stage-discharge rating curves for the Outlet Channels in the model were taken from the KGS Assiniboine River & Lake Manitoba Basins Flood Mitigation Study finalized in 2016 (will be referred to as the ARLM study). It was also assumed that the fish ladder would be removed from the Fairford River Water Control Structure to increase outflow capacity.

The daily inflows form the Portage Diversion had to be simulated under the assumption of a consistent operating regime for the entire analysis period (1915-2017). It was assumed that the Portage Diversion would be operated according to the rules proposed in the Provincial Flood Control Infrastructure Review of Operating Guidelines Report - August 2015 (Appendix B) and that the capacity of the Assiniboine River dikes would be 18,000 cfs. The simulated flows were developed by applying the operating rules to historical daily Assiniboine River flows using algorithms to consider maximum allowable flow on the Assiniboine River, James Avenue water levels, volume of water to be diverted to Lake Manitoba, and Lake Manitoba forecasted peak water level. Manual adjustments were made in some years to capture how the province would actually operate in certain situations rather than rigidly applying the operating guidelines. Examples of this would be timing of operation for ice break-up and not operating if a target threshold is only going to be exceeded by a small amount.

Hydrographs showing simulated water levels and flows are attached in Appendix C.

Proposed Operating Guidelines

As stated previously, the guidelines developed by the 2003 and 2013 Committees for Lake Manitoba and Lake St. Martin regulation were used as the starting point for the development of the operating guidelines for the proposed Outlet Channels. Numerous iterations of operating regimes for the Outlet Channels were simulated to develop an optimal operating regime that would maximize flood protection while staying true to the principles laid out by the 2003 and 2013 review committees; namely, the desired regulation range, minimization of operations when within the desired regulation range, and maintaining a desired minimum flow on the Fairford River.

Consideration was also given to the impact of outlet channel operation during the winter on the stability of ice. Ice stability is an important factor for safe working conditions for the commercial fishery and for avoiding damage and scouring along the outlet channels.

The proposed operating guidelines are summarized in Appendix A. The following is a discussion of the rationale behind the proposed guidelines.

Fairford River Water Control Structure

The Technical Committee agreed that the current operating guidelines for the Fairford River Water Control Structure should not be changed. These operating guidelines were recommended by the 2003 Lake Manitoba Regulation Review Advisory Committee and the 2013 Lake Manitoba, Lake St. Martin Regulation Review Committee and are the result of extensive analyses and consultations.

Lake Manitoba Outlet Channel

1. *The Lake Manitoba Outlet Channel will be opened to maximum capacity when Lake Manitoba is above the top of the regulation range (812.5 ft),*

This operating guideline conforms with the principle of minimizing operations within the desired regulation range (810.5 ft – 812.5 ft)

2. ***The Lake Manitoba Outlet Channel may be opened pro-actively (when the water level is below 812.5 ft) if the water level on Lake Manitoba is forecasted to be above 813 ft in the same season (REV 1).***

REV 1 (2019-01-24) – This allows for pro-active operation for larger floods but also maintains the spirit of the operating guidelines recommended by the 2003 and 2013 Committees (i.e., water levels are generally maintained between 810.5 to 812.5 ft with the expectation that water levels will occasionally reach 810.0 ft or lower on the low side, and 813.0 ft or higher on the high side). Modelling of the 103 years with data indicated that Operating Guideline #2 has minimal impact on reducing the peak water level when compared to no pro-active operation (i.e., outlet only open when water level is above 812.5 ft). However, it will likely be widely supported over a reactive approach based on perceived effectiveness.

3. *The outflow from the Lake Manitoba Outlet Channel will be reduced when the water level on Lake Manitoba recedes to the middle of the regulation range (811.5 ft), so that the combined flow through the Fairford River Water Control Structure and in the Lake Manitoba Outlet Channel, insofar as practicable, matches the inflow into Lake Manitoba.*

This operating guideline is consistent with the Fairford River Water Control Structure operating guidelines with respect to the lake level of 811.5 ft. However, it differs in its requirement that the total lake outflow has to match total Inflows when at the middle of the regulation range. The initial version of this guideline specified that the Lake Manitoba Outlet Channel would be shut off when the Lake Manitoba water level receded below 811.5 ft; however, this created an undesirable effect in certain years where peak water levels from the Lake Manitoba Outlet Channel simulation were higher than the simulated peak water levels without the new Outlet Channel. This is because in some simulation years the operation of the Lake Manitoba Outlet Channel decreased the water level to the middle of the regulation range whereas lake regulation without the Lake Manitoba outlet channel would not have. Consequently, the Fairford River Water Control Structure is reduced to 60% capacity in the simulation with the Lake Manitoba Outlet Channel while the Fairford River Water Control Structure is left at 100% in the simulation without the Lake Manitoba Outlet Channel resulting in higher lake levels the following year in the simulation with the Lake Manitoba Outlet Channel.

Figure 1 shows peak level increases comparing the simulated peaks under the assumption that the Lake Manitoba Outlet is closed when the lake level reaches 811.5 ft, to the simulated peaks under the current operating regime. As shown in the figure, the effect of shutting off the Lake Manitoba Outlet Channel at 811.5 ft results in an increase in peak water level of 0.1 ft or more 19 times. Sixteen of the nineteen instances of peak increase result in levels above the regulation range (812.5 ft). Figure 2 highlights the effects of using the Lake Manitoba Outlet to match inflows into Lake Manitoba once Lake Manitoba reaches 811.5 ft. As can been seen, this adjustment to the operating regime reduces the number of times that peak water levels under the proposed operating regime is higher than 0.1 ft above the peak for the current operating regime from 19 to 4. In three of the four instances, the Lake Manitoba peak level is above 812.5 ft; however, the highest peak in these four instances is only 812.67 ft.

Figure 1

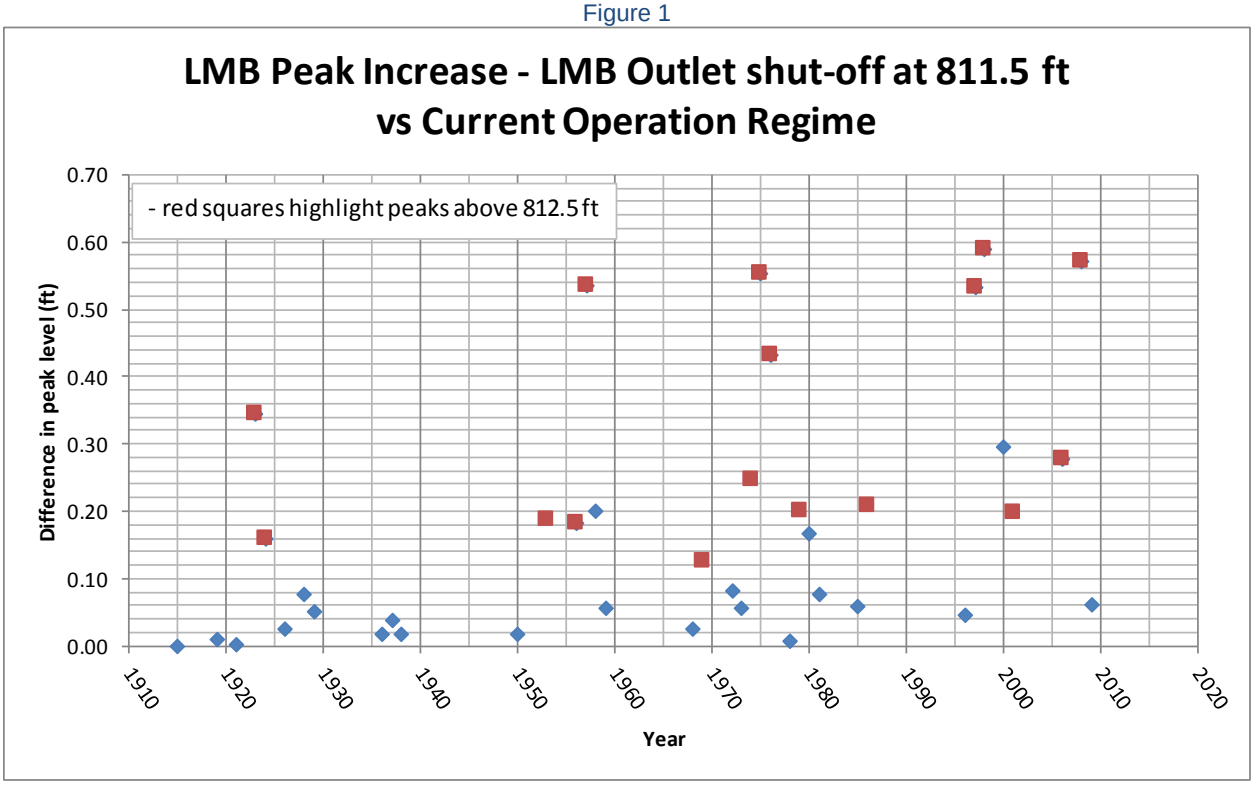
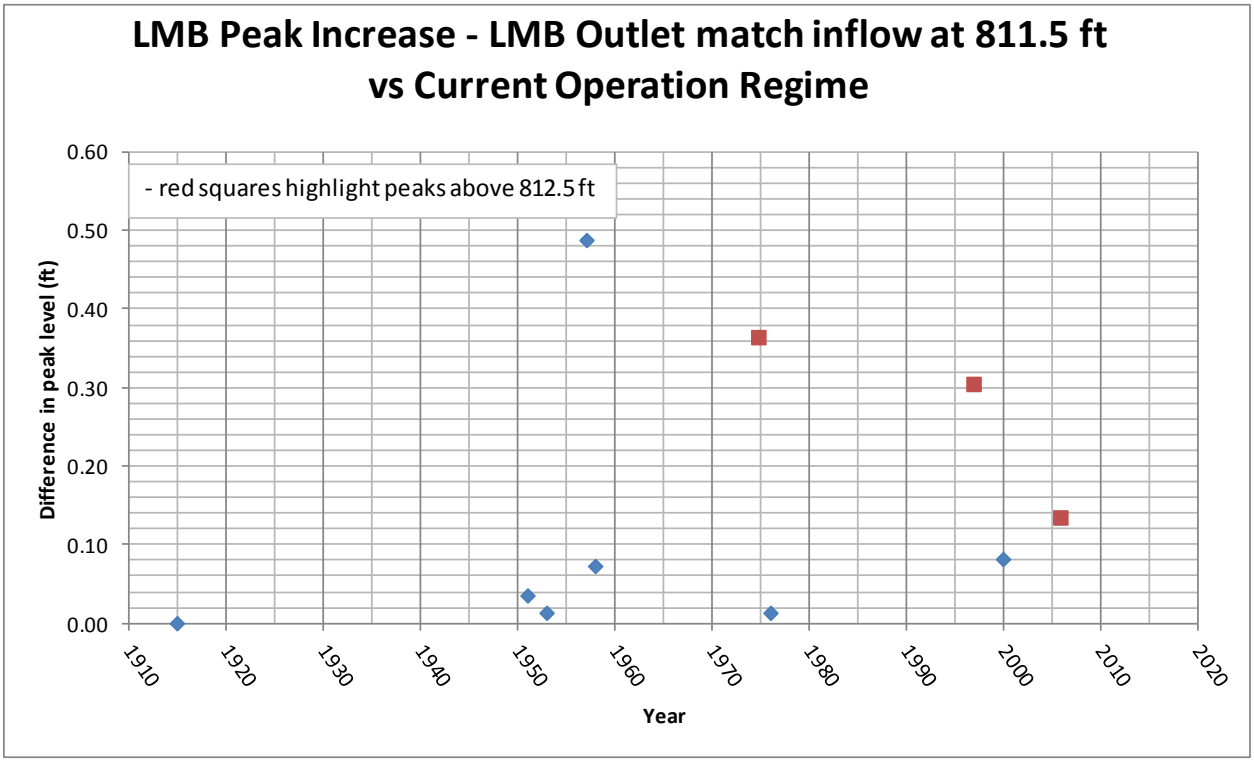


Figure 2



It should be noted that the implementation of proposed guideline #3 increases the number of operating days for the Lake Manitoba Outlet Channel by almost two-fold over the simulation

period when compared to simply shutting off the Lake Manitoba Outlet at the middle of the regulation range.

4. *The Lake Manitoba Outlet Channel will be closed once the Lake Manitoba water level recedes below 811.5 ft and the flow through the Fairford River Water Control Structure is greater than the total inflow into Lake Manitoba.* ***During Outlet Channel shutdown, consideration will be given to ensuring that the drawdown rate within the Outlet Channel does not compromise channel embankment stability (REV 1).***

The first part of this guideline is the extension of Guideline #3. **REV 1 (2019-02-07) – The second part of the guideline ensures that flow is not reduced too rapidly, in order to maintain embankment stability.**

5. *Initial operation of the outlet control structure will not be initiated during the period in which there is solid ice cover in the channel (typically from Dec 1 – April 30th**). However, operation may be considered if severe flooding is forecasted for the following spring (REV 1).***

This guideline was developed to prevent break-up of solid ice pans in the Lake Manitoba Outlet Channel during winter. The movement of ice pans could potentially result in scouring of the Outlet Channel banks and could cause ice stability issues on Lake St. Martin for the commercial ice fishermen. **REV 1 (2019-02-07) – Includes an exception for when severe flooding is forecasted.**

<u>Lake St. Martin Outlet Channel</u>

1. *The target regulation range for Lake St. Martin is 797-800 ft*

Consistent with the recommendations of the 2003 and 2013 Regulation Review Committees.

2. *The Lake St. Martin Outlet Channel will be operated to full capacity:*

    a. *when the Lake St. Martin water level rises above 800 ft*

    or

    b. *when the Lake Manitoba Outlet is opened for initial operation, Lake St. Martin is above 797 ft, and* ***Lake St. Martin is forecasted to go above 800 ft without operation of the Lake St. Martin Outlet Channel (REV 1).***

    Consideration may be given to opening the Lake St. Martin Outlet Channel to less than full capacity if Lake St. Martin is forecasted to go only slightly above 800 ft (REV1).

Part “a” of this guideline is consistent with the recommended regulation range. Part “b” of this guideline is required to avoid major water level spikes on Lake St. Martin as Lake St. Martin rises rapidly when the Lake Manitoba Outlet Channel is open. **REV 1 (2019-02-07) – Includes wording to ensure that the Outlet Channel is only open when Lake St. Martin is**

forecasted to go above 800 ft. Also provides some leeway for operating to less than full capacity should Lake St. Martin only go slightly above 800 ft.

3. *The outflow from the Lake St. Martin Outlet Channel will be reduced when the lake level decreases below 800 ft, to the greater of the following:*

    a. ***25% (REV 1)** of channel capacity,*

    b. *the outflow required to ensure the combined flows in the Dauphin River and the Lake St. Martin Outlet Channel matches the total inflow into Lake St. Martin*

This guideline is in line with Guideline #2 for the Lake Manitoba Outlet Channel and allows for more stability in Lake St. Martin water levels when within regulation range. **REV 1 (2019-02-07) – The original minimum channel capacity setting was set to 50% by the Technical Committee. It is recommended that this be reduced to 25% as the 50% minimum results in drawing down the lake too quickly.**

4. ***The flow in the Lake St. Martin Outlet Channel will be further reduced when the water level on Lake St. Martin recedes below 798 ft, so that the combined flows in the Dauphin River and in the Lake St. Martin Outlet Channel, insofar as practicable, matches the inflow into Lake St. Martin (REV 1)***

REV 1 (2019-01-02) – It is recommended that this guideline be included to eliminate rapid water level rises that were observed to occur upon closure of the Lake St. Martin Outlet Channel in some of the simulation years.

5. *The Lake St. Martin Outlet Channel will be closed fully when Lake St. Martin drops below 798 ft **and the outflow from the Dauphin River is equal to or greater than the total inflow into Lake St. Martin from the (REV 1)** during the period from when ice cover has cleared out of the channel in the spring to October 31st. **During channel shutdown consideration will be given to ensuring that the drawdown rate within the Outlet Channel does not compromise channel embankment stability (REV 1).***

Setting the shut-off trigger below 797 ft was considered; however, it caused the lake to drop below 797 ft (lower than the desired regulation range) in too many years. **REV 1 (2019-02-07) – The additional clause of waiting until outflows to Dauphin River match inflows is recommended to conform with Lake St. Martin Channel guideline #4. The second part of the guideline ensures that flow is not cut back too rapidly for embankment stability.**

6. *If the Lake Manitoba Outlet is in operation in November, the Lake St. Martin Outlet Channel should be operated throughout the winter so that the combined flows in the Dauphin River and in the Lake St. Martin Outlet Channel, insofar as practicable, matches the inflow into Lake St. Martin.*

This guideline is intended to maintain a stable water level on Lake St. Martin over the winter to promote ice stability for the commercial fishery. Shutting down the Lake St. Martin Outlet

Channel over winter results in a rapid increase in water levels on Lake St. Martin when the Lake Manitoba Outlet Channel is still in operation.

7. *Notwithstanding the above guidelines, the Lake St. Martin Outlet Channel will be operated during the spring freshet if the Lake Manitoba Outlet Channel has been in operation over the winter and will continue to be operated into the spring, so that the combined flows in the Dauphin River and the Lake St. Martin Outlet Channel, insofar as practicable, matches the inflow into Lake St. Martin.*

This guideline captures the transition from winter to spring in situations where Lake St. Martin Outlet Channel was not in operation during the winter but the Lake Manitoba Outlet Channel was in operation. Waiting for Lake St. Martin to rise to 800 ft before opening the outlet channel in this situation causes a very rapid spike in Lake St. Martin.

8. *Initial operation of the outlet control structure will not be initiated during the period in which there is solid ice cover in the channel (typically from Dec 1 – April 30th). However, operation* ***may be considered if severe flooding is forecasted for the following spring (REV 1).***

This guideline was developed to prevent break-up of solid ice pans in the Lake St. Martin Outlet Channel during winter. The movement of ice pans could potentially result in scouring of the Outlet Channel banks and could cause ice stability issues on Lake Winnipeg for the commercial ice fishermen. **REV 1 (2019-02-07) – Includes an exception for when severe flooding is forecasted.**

It is assumed that Lake Manitoba and Lake St. Martin Outlet Channel gate settings will be adjusted when required on a weekly or biweekly basis rather than on a daily basis. This means that gate settings made to match inflows and outflows may not perfectly balance inflows and outflows for the whole period between gate operations.

<original signed by>

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Cc: E. Kozera
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P. Johnston

Appendix A:

Proposed Lake Manitoba and Lake St. Martin Operating Guidelines

Lake Manitoba and Lake St. Martin Outlet Operating Guidelines

Any variances in the lake levels outside of the target regulation ranges specified below shall be shared between Lake Manitoba and Lake St. Martin insofar as this may be reasonably practicable.

It is assumed that Lake Manitoba and Lake St. Martin Outlet Channel gate settings will be adjusted when required on a weekly or biweekly basis rather than on a daily basis. This means that gate settings made to match inflows and outflows may not perfectly balance inflows and outflows for the whole period between gate operations.

Lake Manitoba

Fairford River Water Control Structure

1. The target regulation range on Lake Manitoba is 812.5 ft to 810.5 ft.
2. During recovery from flood conditions on Lake Manitoba, the Fairford River Water Control Structure is kept wide open until Lake Manitoba recedes to the middle of the range after which is should be cut back to a normal setting (50-60% capacity).
3. During recovery from drought, the Fairford River Water Control Structure is kept at 800 cfs until Lake Manitoba levels increase to middle of the range after which point the structure will be operated to achieve normal outflow (50-60% capacity).
4. Under normal operating conditions, once outflow reaches normal, there are no further stop-log adjustments, as long as Lake Manitoba remains within the range.
5. The minimum flow on the Fairford River should be 800 cfs with a desirable flow of 1,000 cfs as often as practicable.

Lake Manitoba Outlet Channel

1. The Lake Manitoba Outlet Channel will be opened to maximum capacity when Lake Manitoba is above the top of the regulation range (812.5 ft*),*
2. **The Lake Manitoba Outlet Channel may be opened pro-actively (when the water level is below 812.5 ft) if the water level on Lake Manitoba is forecasted to be above 813 ft in the same season (REV 1).**
3. The outflow from the Lake Manitoba Outlet Channel will be reduced when the water level on Lake Manitoba recedes to the middle of the regulation range (811.5 ft), so that the combined flow through the Fairford River Water Control Structure and in the Lake Manitoba Outlet Channel, insofar as practicable, matches the inflow into Lake Manitoba.

4. The Lake Manitoba Outlet Channel will be closed once the Lake Manitoba water level recedes below 811.5 ft and the flow through the Fairford River Water Control Structure is greater than the total inflow into Lake Manitoba. **During Outlet Channel shutdown, consideration will be given to ensuring that the drawdown rate within the Outlet Channel does not compromise channel embankment stability (REV 1).**
5. Initial operation of the outlet control structure will not be initiated during the period in which there is solid ice cover in the channel (typically from Dec 1 – April 30th). **However, operation may be considered if severe flooding is forecasted for the following spring (REV 1).**

Lake St. Martin

Lake St. Martin Outlet Channel

1. The target regulation range for Lake St. Martin is 797-800 ft
2. The Lake St. Martin Outlet Channel will be operated to full capacity:
   a. when the Lake St. Martin water level rises above 800 ft

      or

   b. when the Lake Manitoba Outlet is opened for initial operation, Lake St. Martin is above 797 ft, and **Lake St. Martin is forecasted to go above 800 ft without operation of the Lake St. Martin Outlet Channel (REV 1).**

   Consideration may be given to opening the Lake St. Martin Outlet Channel to less than full capacity if Lake St. Martin is forecasted to go only slightly above 800 ft (REV1).

3. The outflow from the Lake St. Martin Outlet Channel will be reduced when the lake level decreases below 800 ft, to the greater of the following:
   a. **25% (REV 1)** of channel capacity,
   b. the outflow required to ensure the combined flows in the Dauphin River and the Lake St. Martin Outlet Channel matches the total inflow into Lake St. Martin
4. **The flow in the Lake St. Martin Outlet Channel will be further reduced when the water level on Lake St. Martin recedes below 798 ft, so that the combined flows in the Dauphin River and in the Lake St. Martin Outlet Channel, insofar as practicable, matches the inflow into Lake St. Martin (REV 1)**

5. The Lake St. Martin Outlet Channel will be closed fully when Lake St. Martin drops below 798 ft **and the outflow from the Dauphin River is equal to or greater than the total inflow into Lake St. Martin from the (REV 1)** during the period from when ice cover has cleared out of the channel in the spring to October 31st. **During channel shutdown consideration will be given to ensuring that the drawdown rate within the Outlet Channel does not compromise channel embankment stability (REV 1).**
6. If the Lake Manitoba Outlet is in operation in November, the Lake St. Martin Outlet Channel should be operated throughout the winter so that the combined flows in the Dauphin River and in the Lake St. Martin Outlet Channel, insofar as practicable, matches the inflow into Lake St. Martin.
7. Notwithstanding the above guidelines, the Lake St. Martin Outlet Channel will be operated during the spring freshet if the Lake Manitoba Outlet Channel has been in operation over the winter and will continue to be operated into the spring, so that the combined flows in the Dauphin River and the Lake St. Martin Outlet Channel, insofar as practicable, matches the inflow into Lake St. Martin.
8. Initial operation of the outlet control structure will not be initiated during the period in which there is solid ice cover in the channel (typically from Dec 1 – April 30th). However, operation **may be considered if severe flooding is forecasted for the following spring (REV 1).**

Appendix B:

Portage Diversion Operation Guidelines Recommended by Provincial Flood Control Infrastructure Review Panel (2015)

Portage Diversion Operation Guidelines Recommended by Provincial Flood Control Infrastructure Review Panel (2015)

Pre-Spring Break-up Operation

1. While there is ice on the Assiniboine River downstream of Portage la Prairie, it is desirable tolimit flows to approximately 5,000 cfs in the river if there is a potential for ice jamming.
2. During the period that there is ice on the reservoir, the water level of the reservoir must not be allowed to exceed 865.0 feet to provide room for releases from breaching of upstream ice jams.
3. If flow forecasts indicate that the Portage Diversion will likely be put into operation, the Diversion should be put into use as soon as practical to flush out snow blockages and in-situ ice.

Spring Run-off Operation

4. During the spring run-off, after the ice has gone from the Assiniboine River downstream of Portage la Prairie:
    a. if the Lake Manitoba level is forecast to peak below 813 feet, maintain a maximum flow in the lower Assiniboine River of 10,000 cfs, reduced as necessary to keep the river level in Winnipeg below 19 feet James Avenue Datum if possible. Even when there is no risk of flooding on Lake Manitoba maintain a target flow of 10,000 cfs in the lower Assiniboine River to minimize the environmental impact of diversion flows on Lake Manitoba.
    b. if the Lake Manitoba level is forecast to peak above 813 feet, and the projected volume of water from the Portage Diversion into Lake Manitoba will be less than 590,000 ac-ft, maintain a flow in the lower Assiniboine River of 12,000 cfs, reduced as necessary to keep the river level in Winnipeg below 20 feet James Avenue Datum.
    c. if the Lake Manitoba level is forecast to peak above 813 feet, and the projected volume of water from the Portage Diversion into Lake Manitoba will be greater than 590,000 ac-ft, increase flows on the Assiniboine River above 12,000 cfs so as to balance impacts between the Lower Assiniboine River and Lake Manitoba, reduced as necessary to keep the river level in Winnipeg below 21 feet James Avenue Datum.

Growing Season Operation

5. On or after May 25th, if Lake Manitoba levels are below 813 feet the lower Assiniboine flow may be limited to 10,000 cfs if the forecast indicates that Lake Manitoba will not go above 813 feet or that the projected volume of water from the Portage Diversion (from May 25th on) will be less than 236,000 ac-ft. Otherwise operate the Portage Diversion so as to balance impacts between the lower Assiniboine River and Lake Manitoba.

6. In years that the spring thaw occurs early (ice clear from the Lower Assiniboine River prior to April 15), flows on the Assiniboine River can be limited to 10,000 cfs at an earlier date than May 25th, conditional on guideline 5.

General

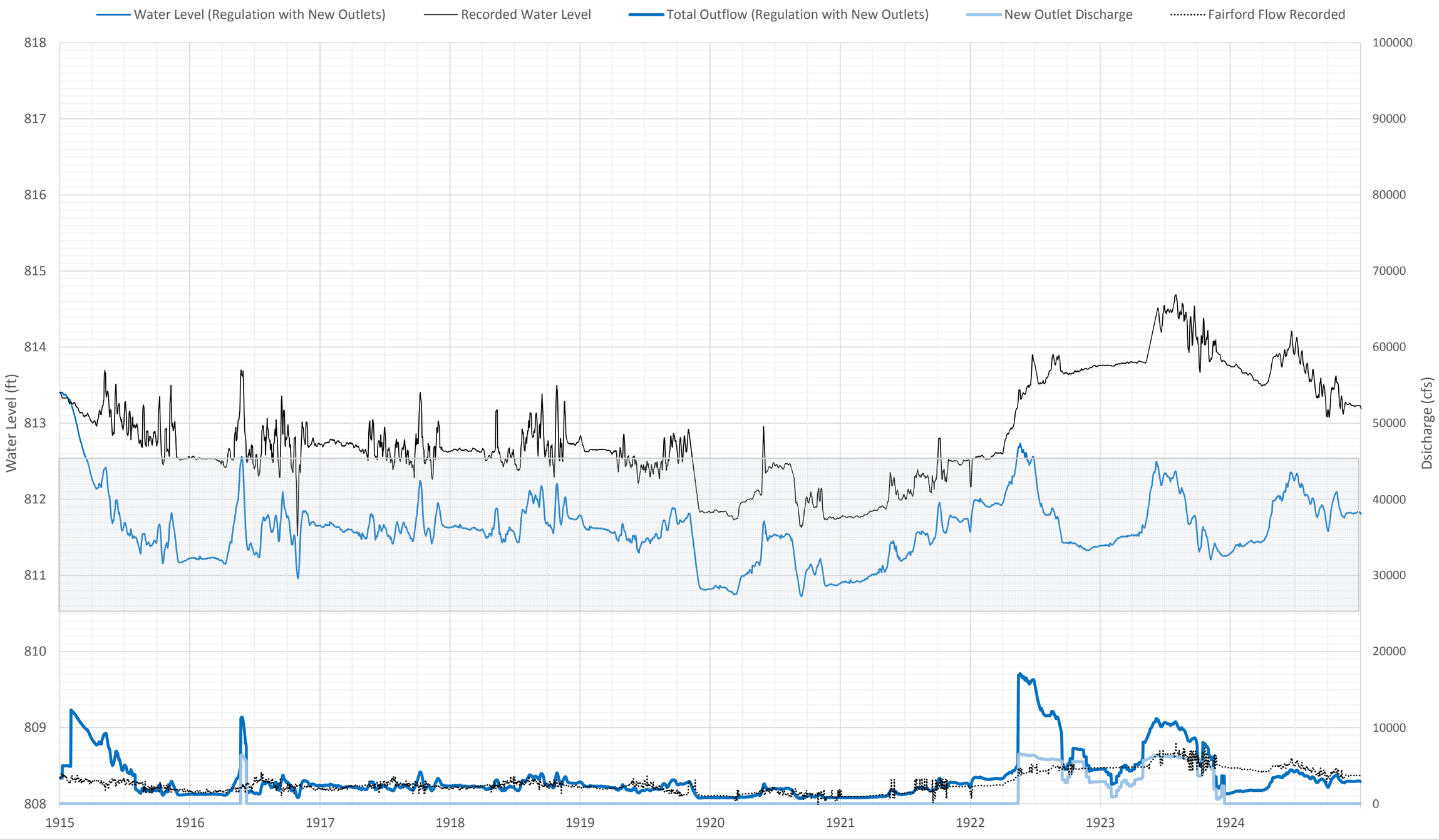
7. The conduit of the spillway structure should be closed while there is water going over thebascule gates.

There may be circumstances in which adhering to the guidelines is determined to be impractical or unbeneficial. In such circumstances the Province shall provide a timely explanation for deviating from the guidelines.

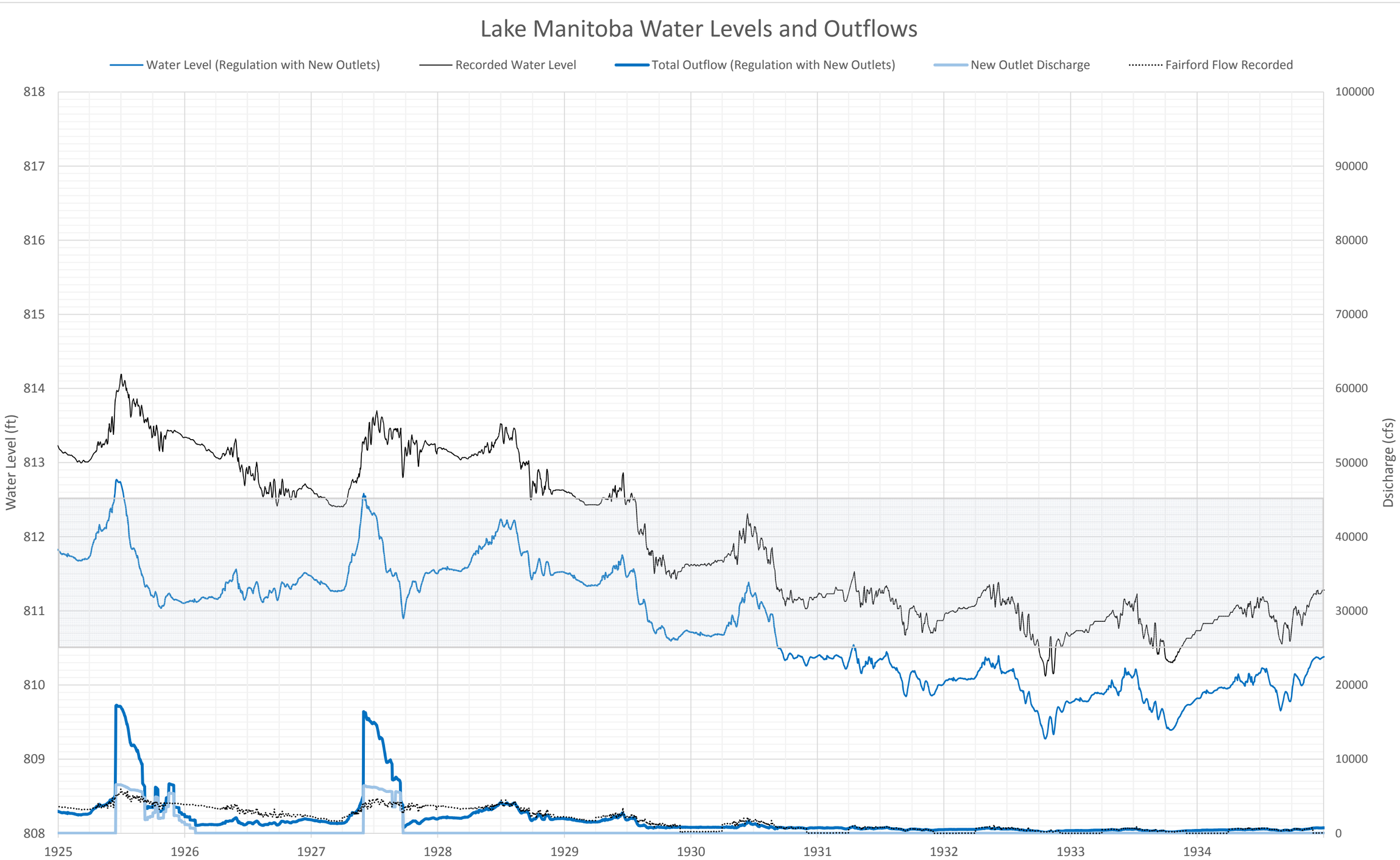
Appendix C:

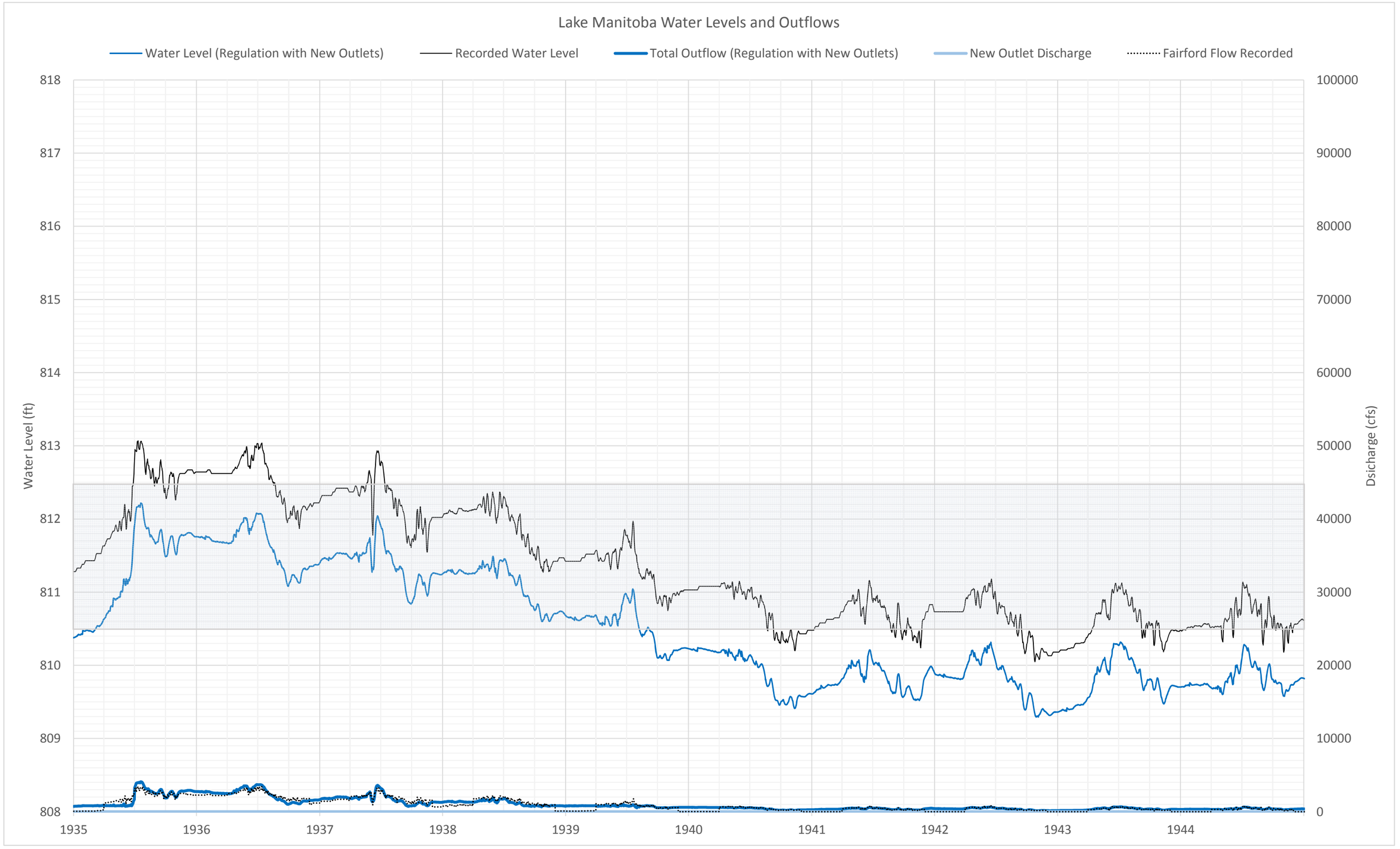
Simulated Hydrographs for Lake Manitoba and Lake St. Martin

Lake Manitoba Water Levels and Outflows



Lake Manitoba Water Levels and Outflows




Lake Manitoba Water Levels and Outflows
Water Level (Regulation with New Outlets)
Recorded Water Level
Total Outflow (Regulation with New Outlets)
New Outlet Discharge
Fairford Flow Recorded
Water Level (ft)
Dsicharge (cfs)
818
817
816
815
814
813
812
811
810
809
808
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
1935
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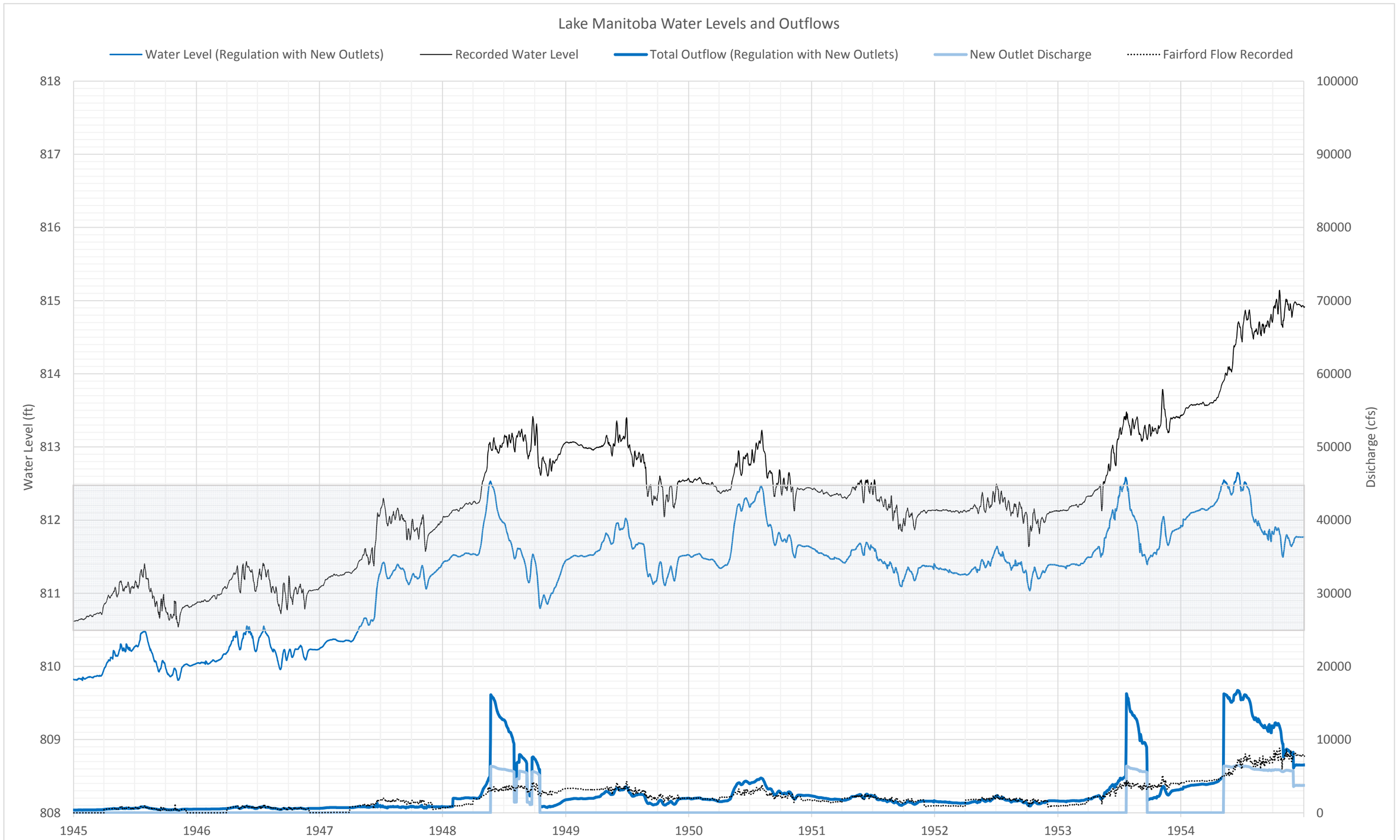
1940
1941
1942
1943
1944


Lake Manitoba Water Levels and Outflows
Water Level (Regulation with New Outlets)
Recorded Water Level
Total Outflow (Regulation with New Outlets)
New Outlet Discharge
Fairford Flow Recorded
Water Level (ft)
Dsicharge (cfs)
818
817
816
815
814
813
812
811
810
809
808
100000
90000
80000
70000
60000
50000
40000
30000
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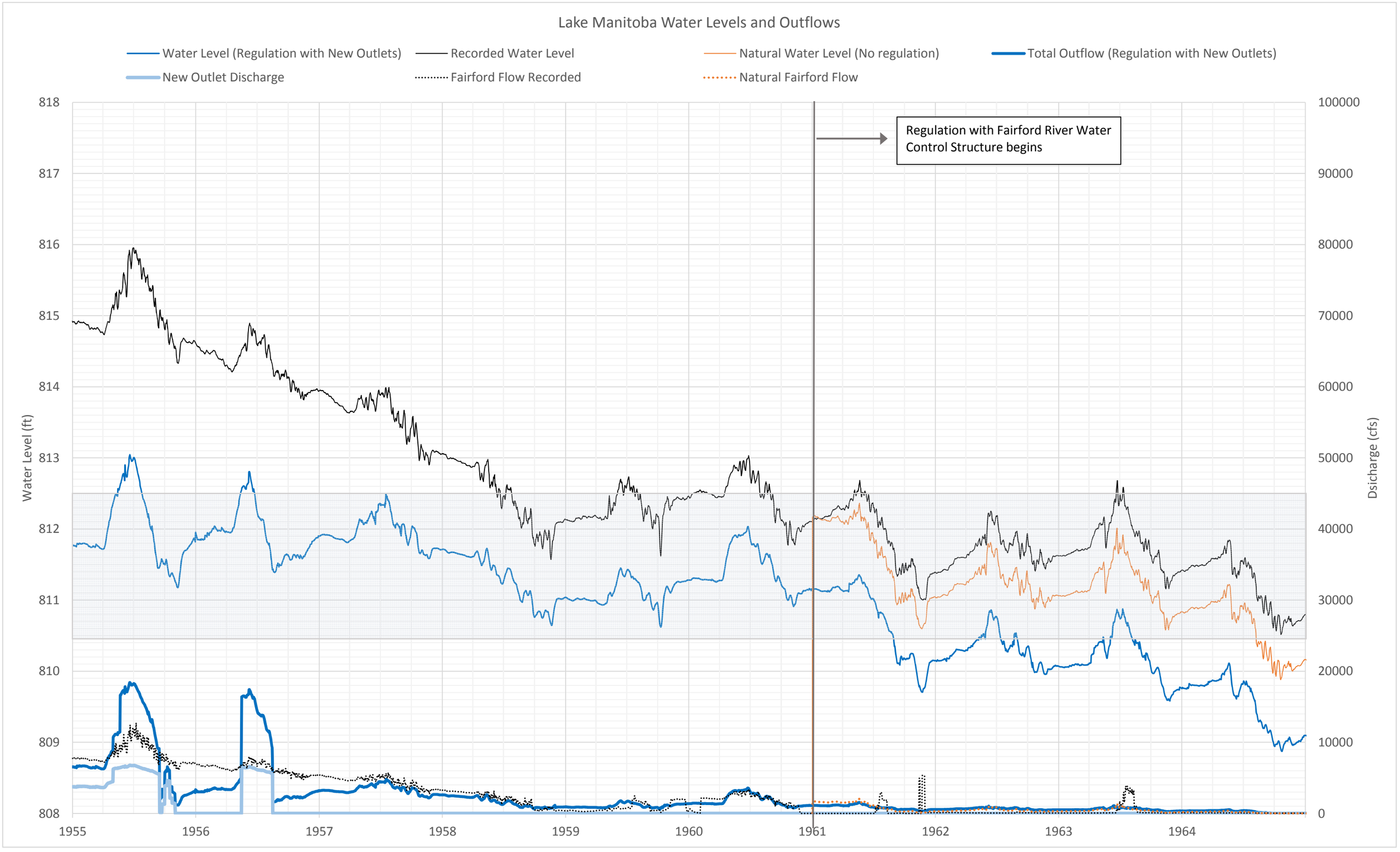
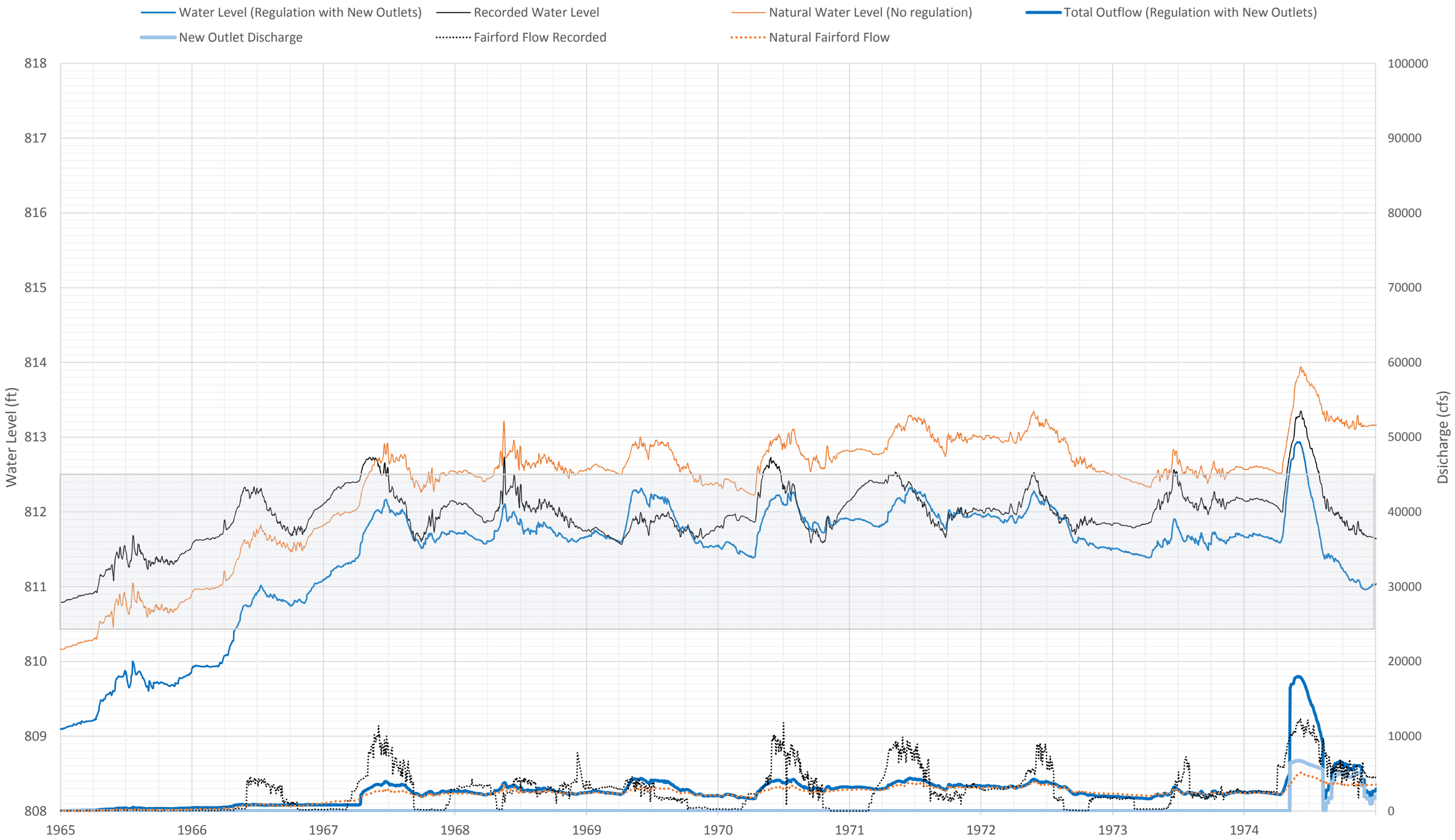
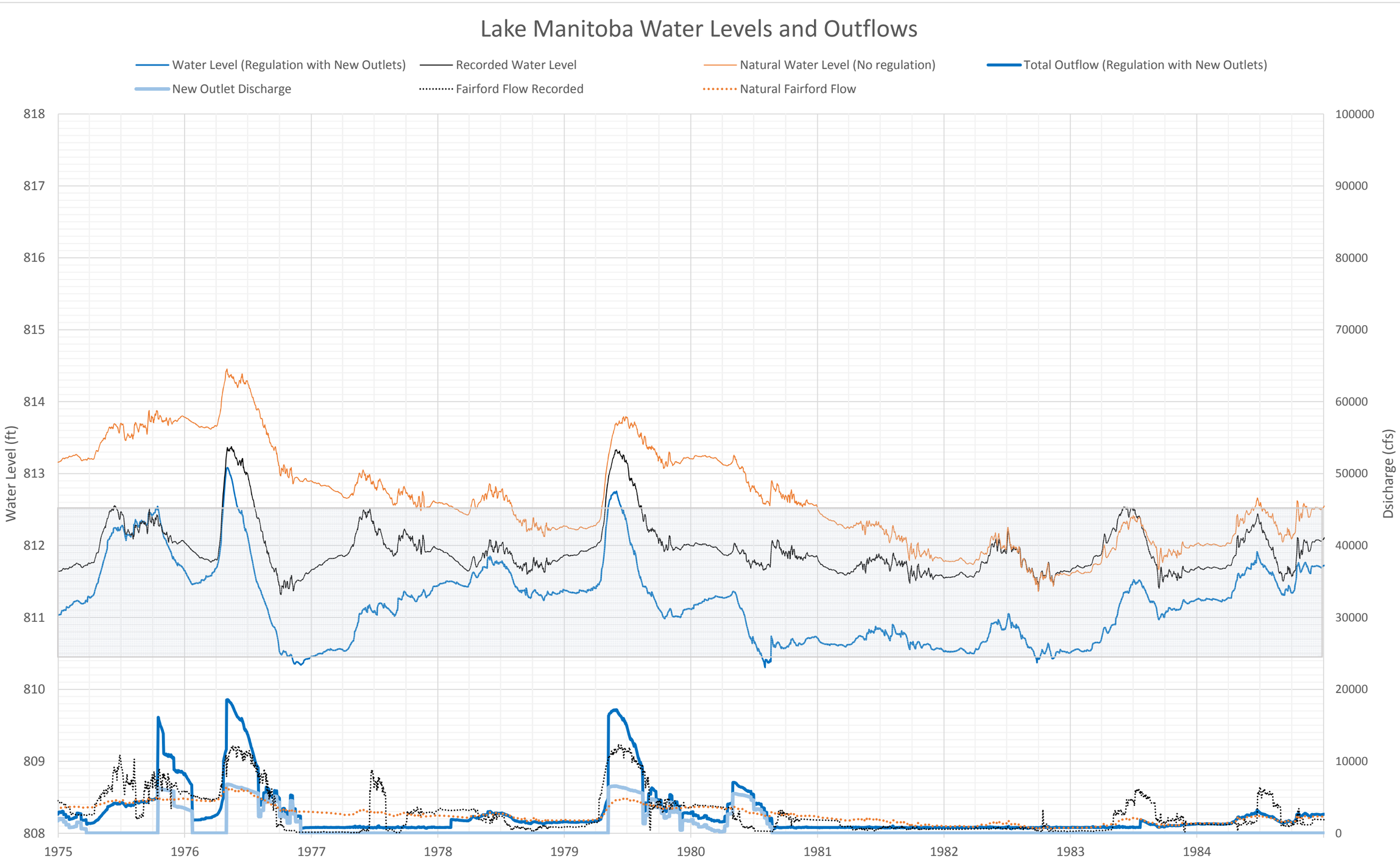
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954


Lake Manitoba Water Levels and Outflows
Water Level (Regulation with New Outlets)
Recorded Water Level
Natural Water Level (No regulation)
Total Outflow (Regulation with New Outlets)
New Outlet Discharge
Fairford Flow Recorded
Natural Fairford Flow
Regulation with Fairford River Water Control Structure begins
Water Level (ft)
Dsicharge (cfs)
818
817
816
815
814
813
812
811
810
809
808
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964

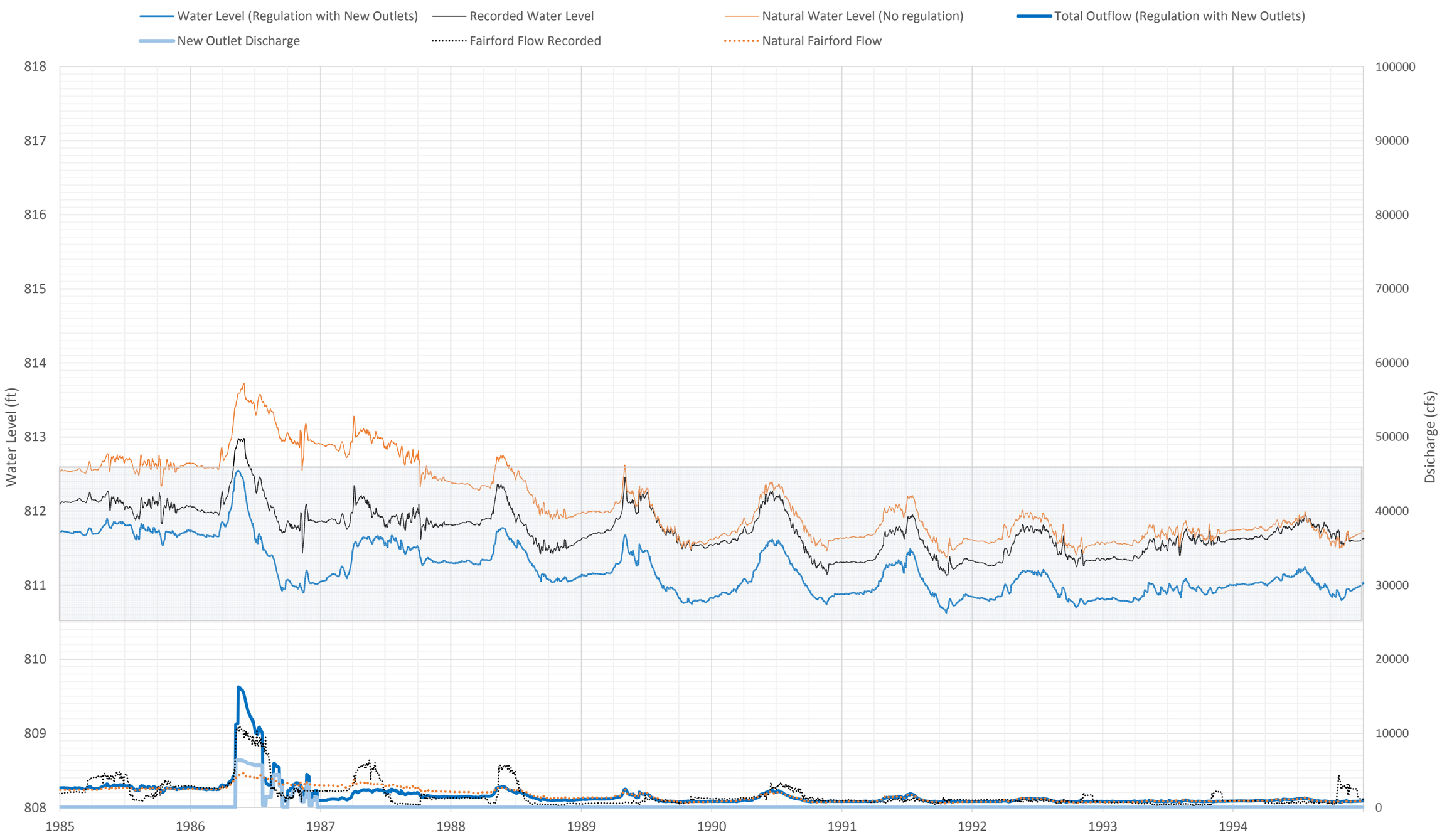
Lake Manitoba Water Levels and Outflows



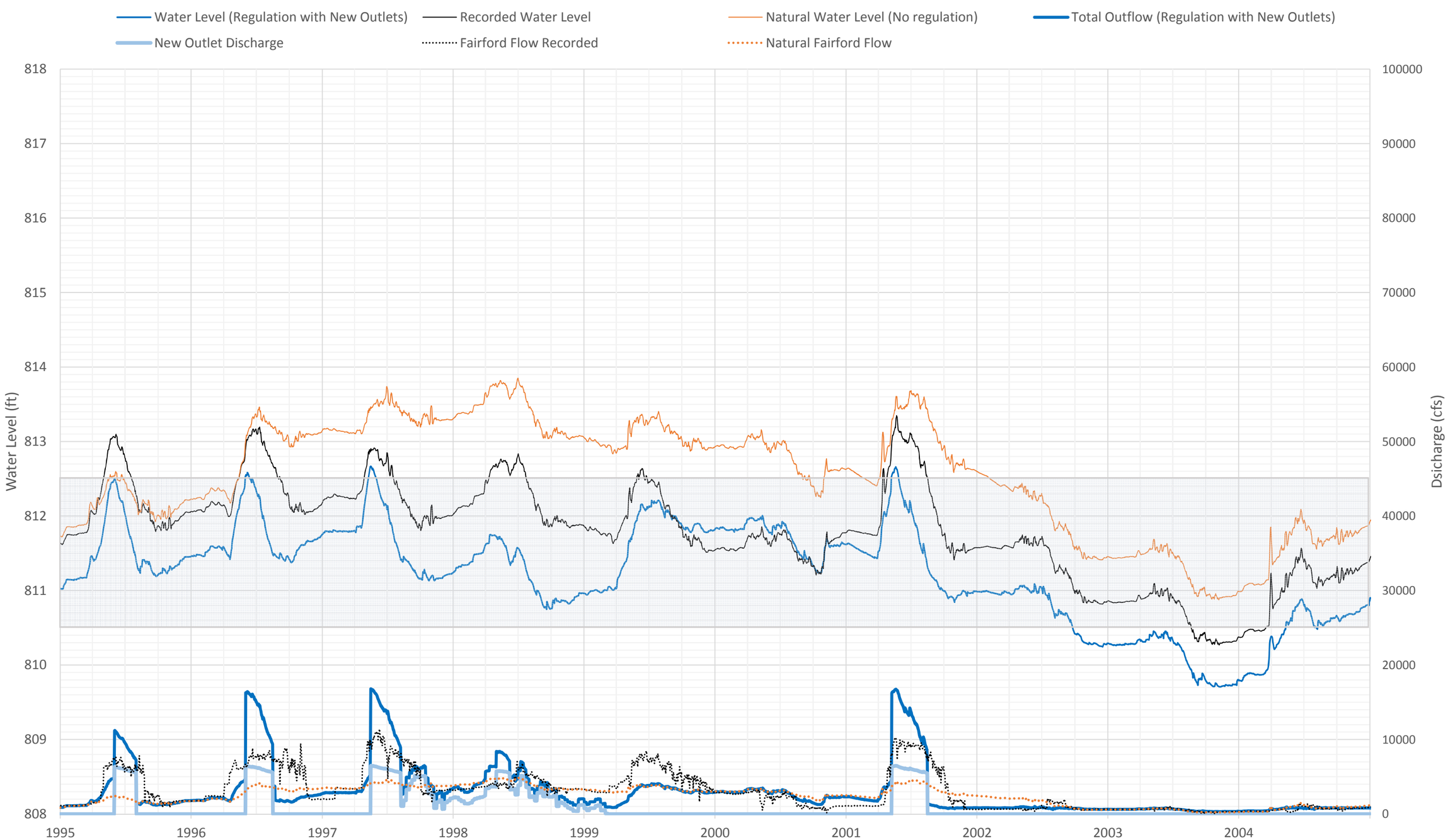
Lake Manitoba Water Levels and Outflows



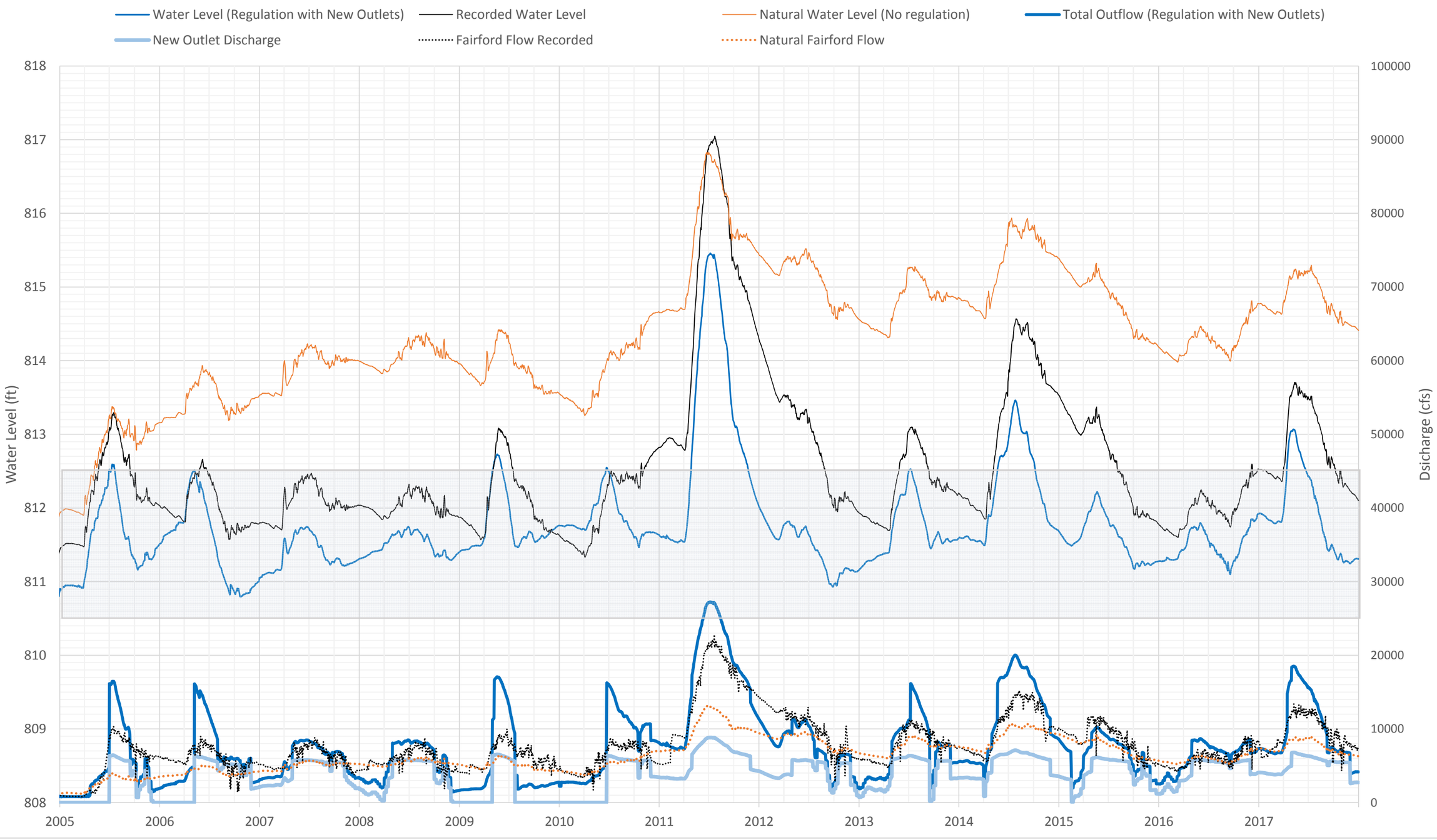
Lake Manitoba Water Levels and Outflows



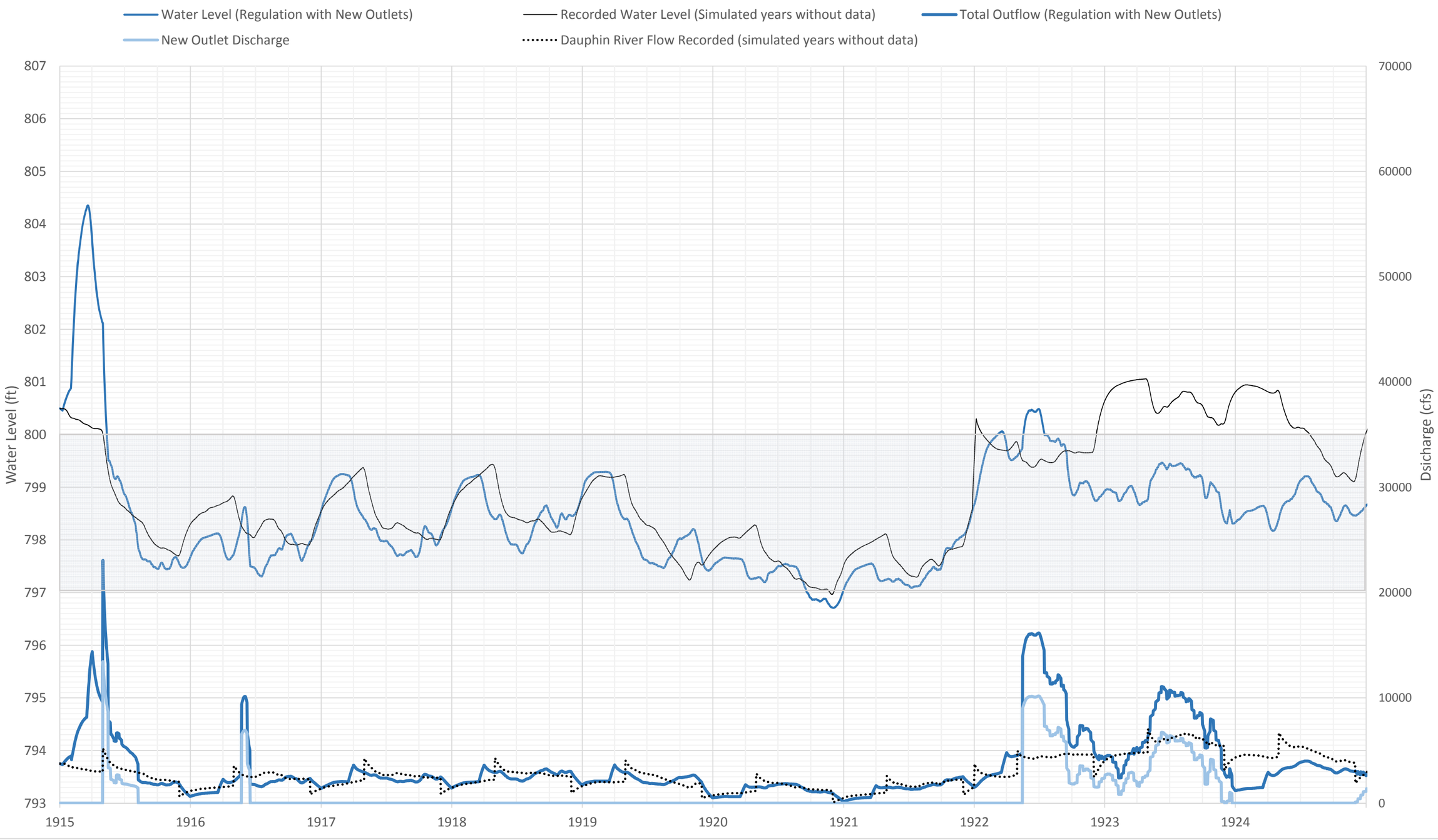
Lake Manitoba Water Levels and Outflows



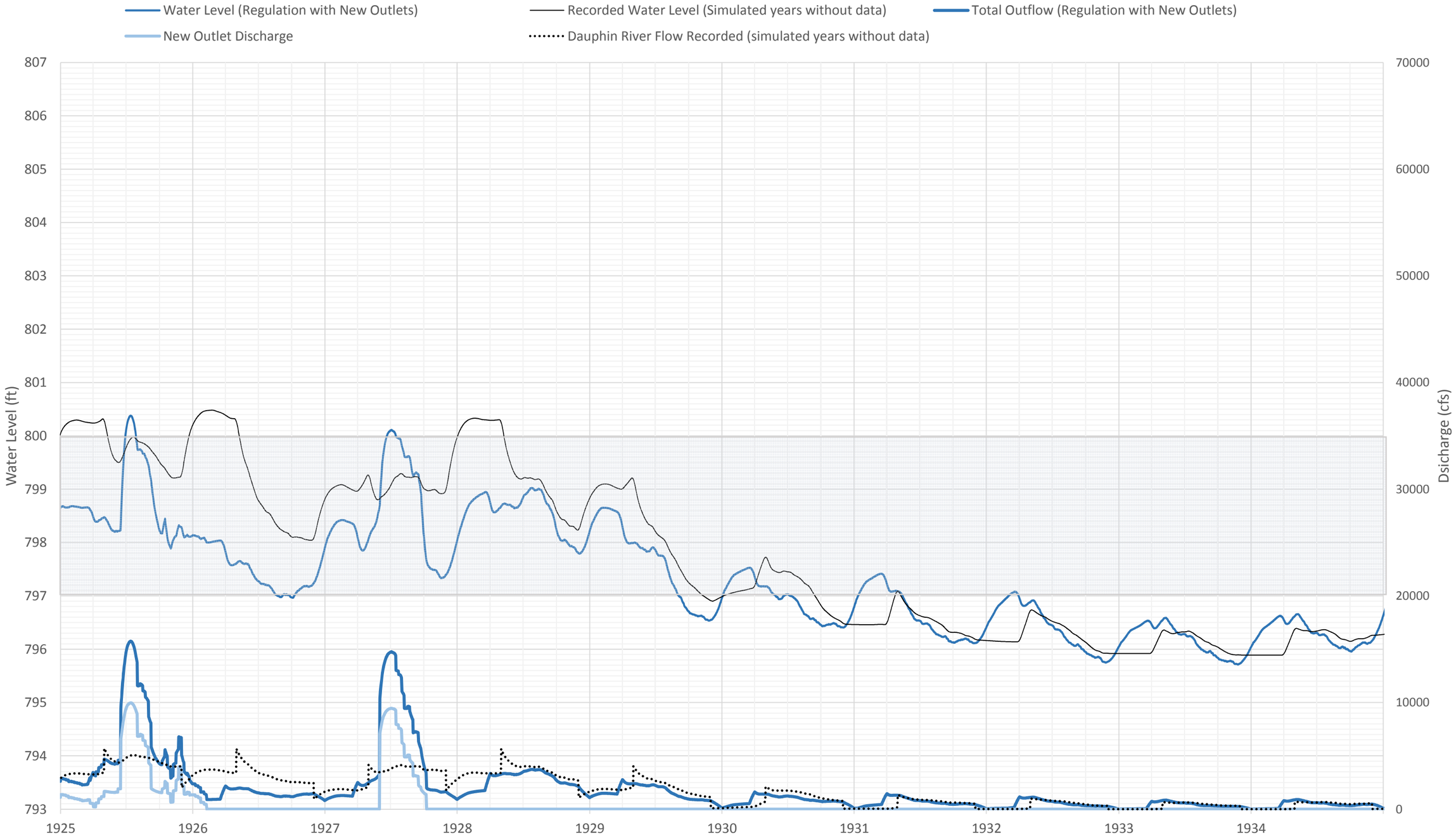
Lake Manitoba Water Levels and Outflows



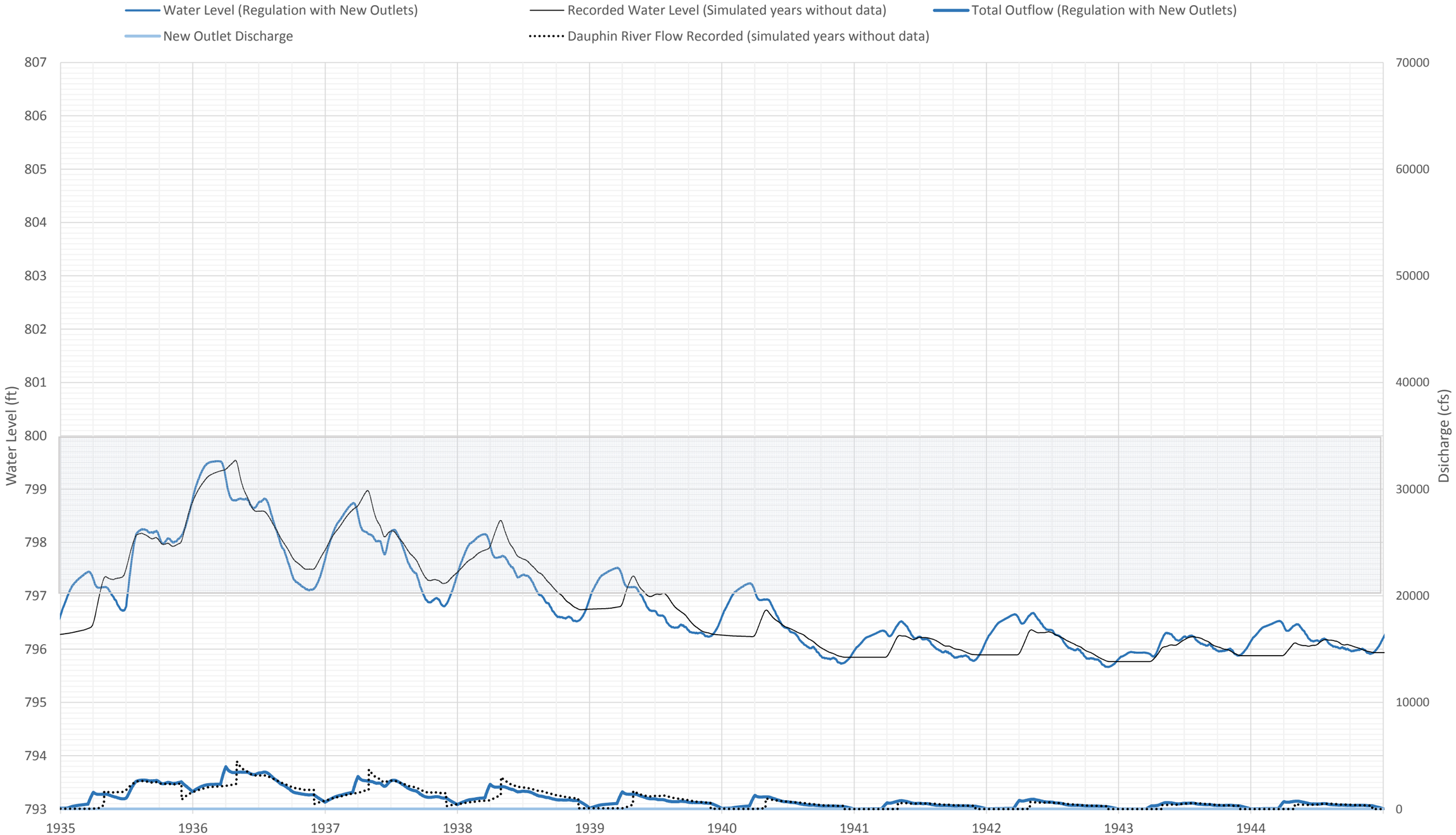
Lake St. Martin Water Levels and Outflows



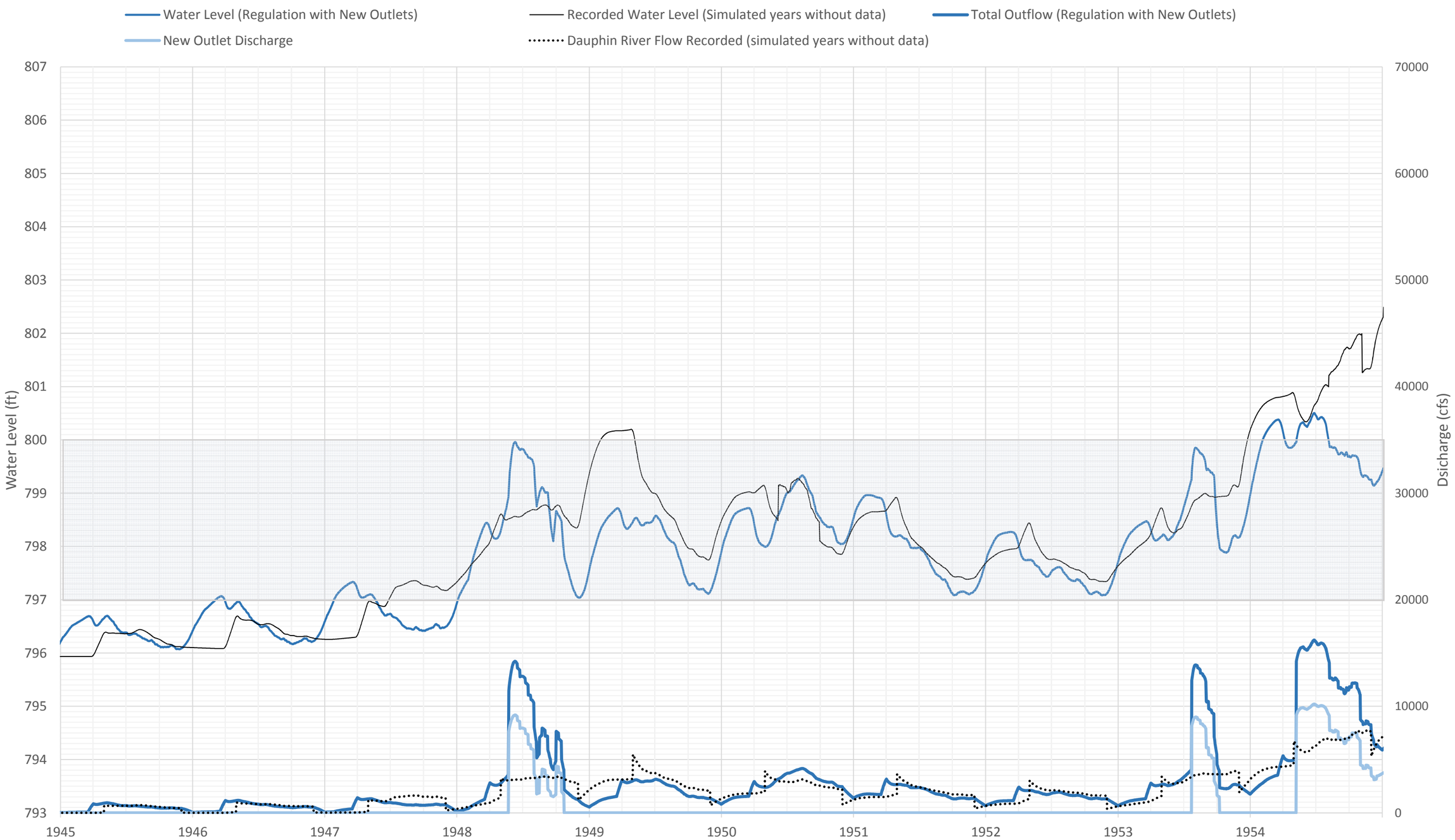
Lake St. Martin Water Levels and Outflows

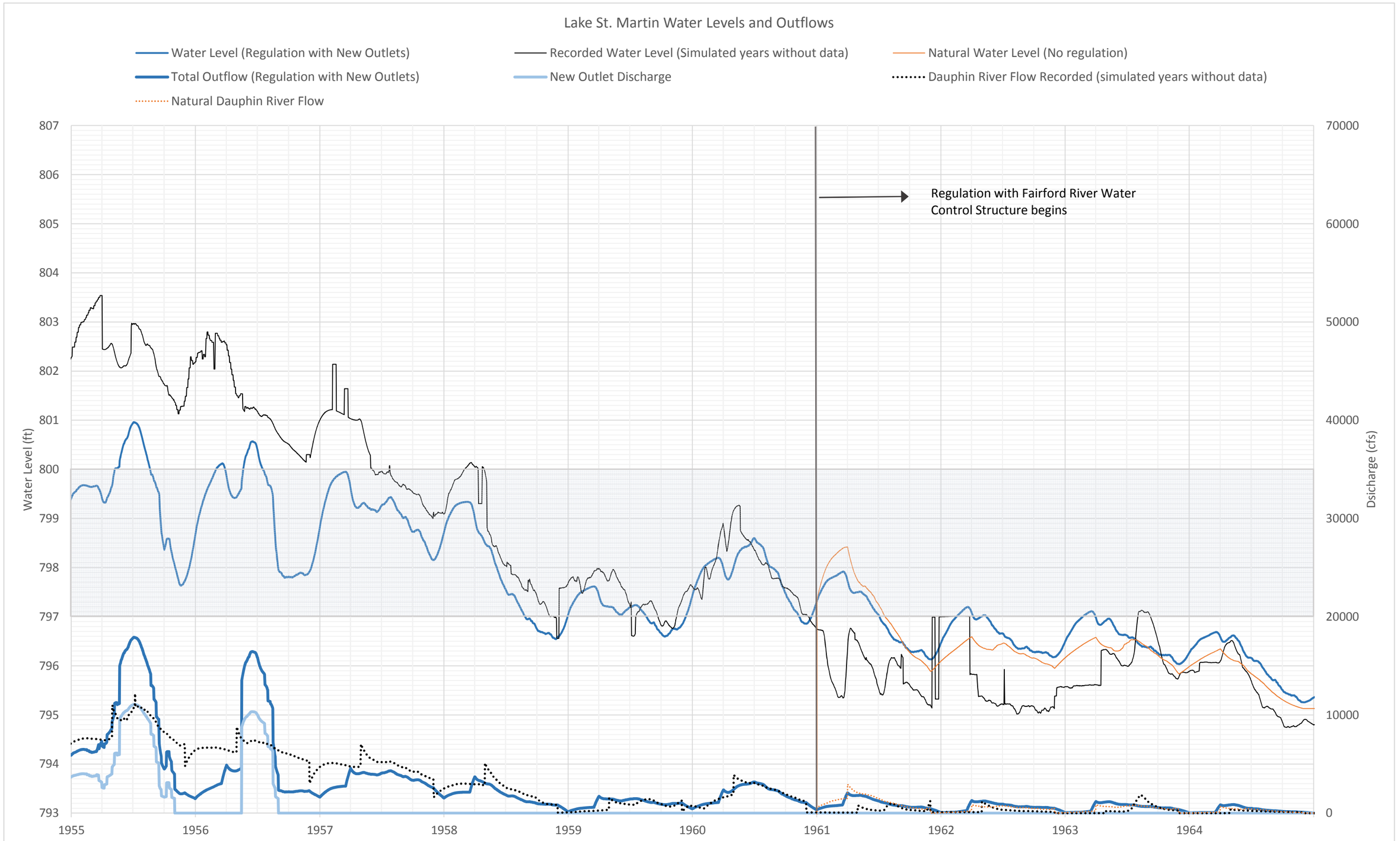


Lake St. Martin Water Levels and Outflows

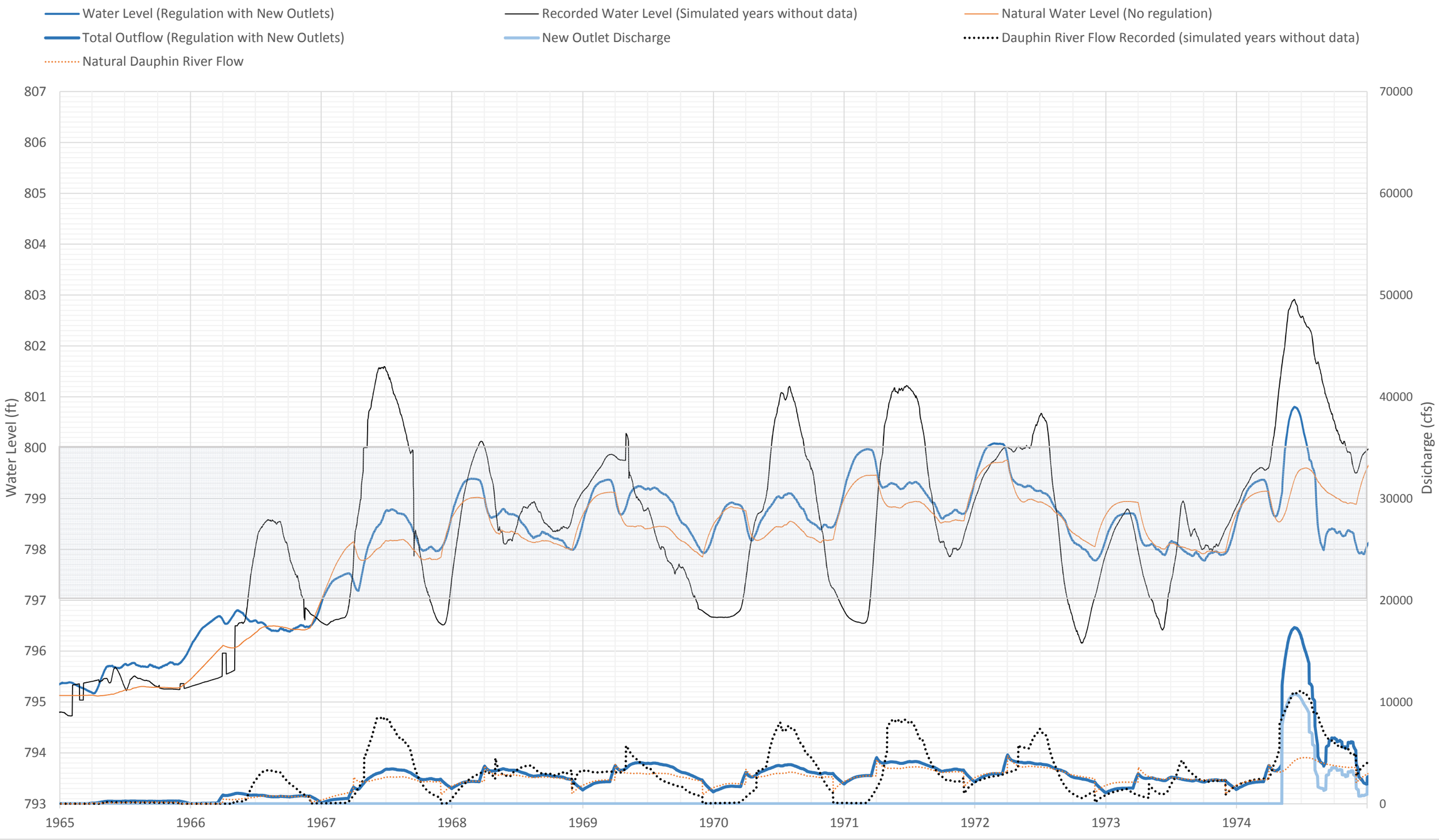


Lake St. Martin Water Levels and Outflows

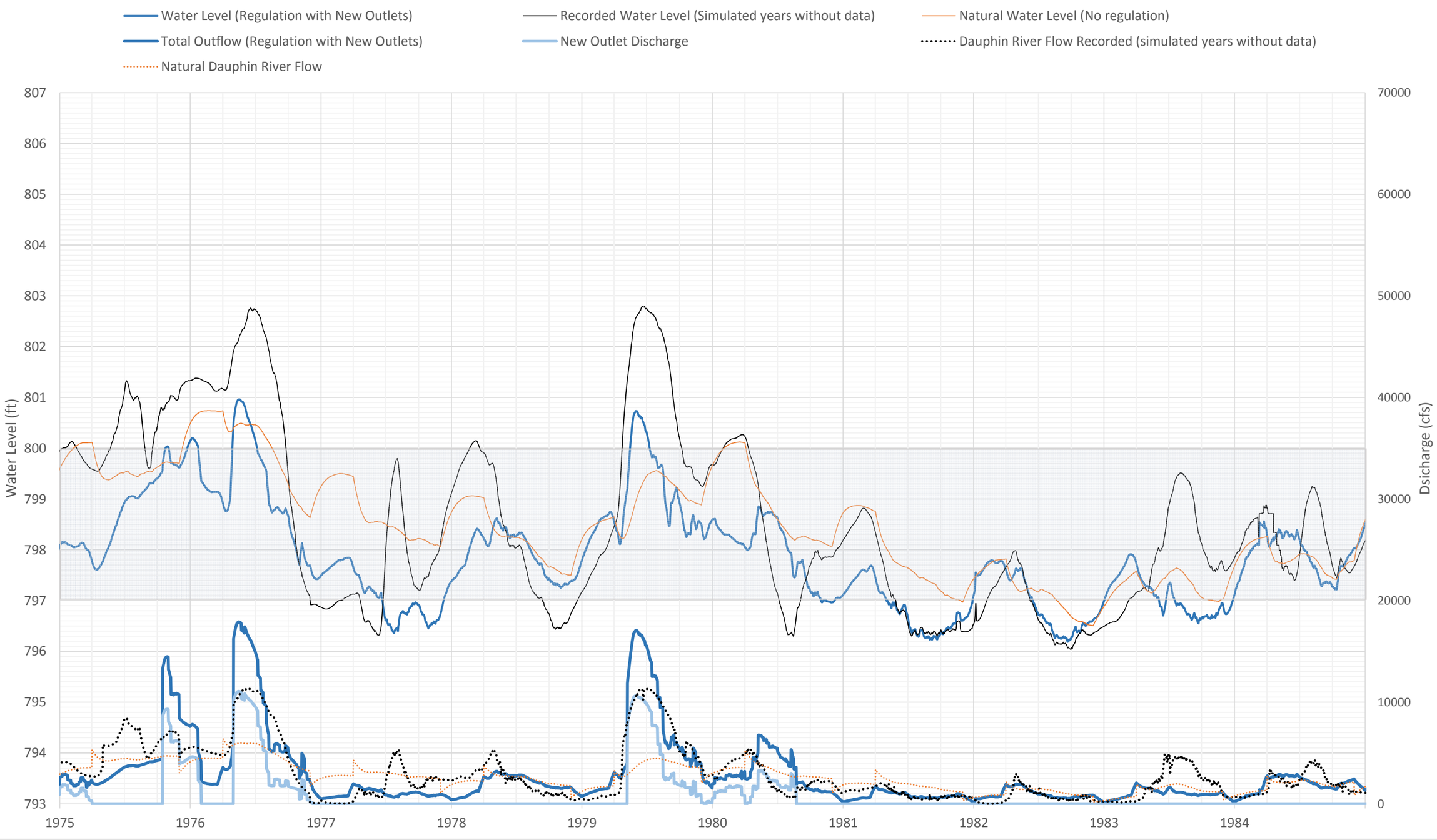



Lake St. Martin Water Levels and Outflows
Water Level (Regulation with New Outlets)
Recorded Water Level (Simulated years without data)
Natural Water Level (No regulation)
Total Outflow (Regulation with New Outlets)
New Outlet Discharge
Dauphin River Flow Recorded (simulated years without data)
Natural Dauphin River Flow
Regulation with Fairford River Water Control Structure begins
Water Level (ft)
Dsicharge (cfs)
807
806
805
804
803
802
801
800
799
798
797
796
795
794
793
70000
60000
50000
40000
30000
20000
10000
0
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964

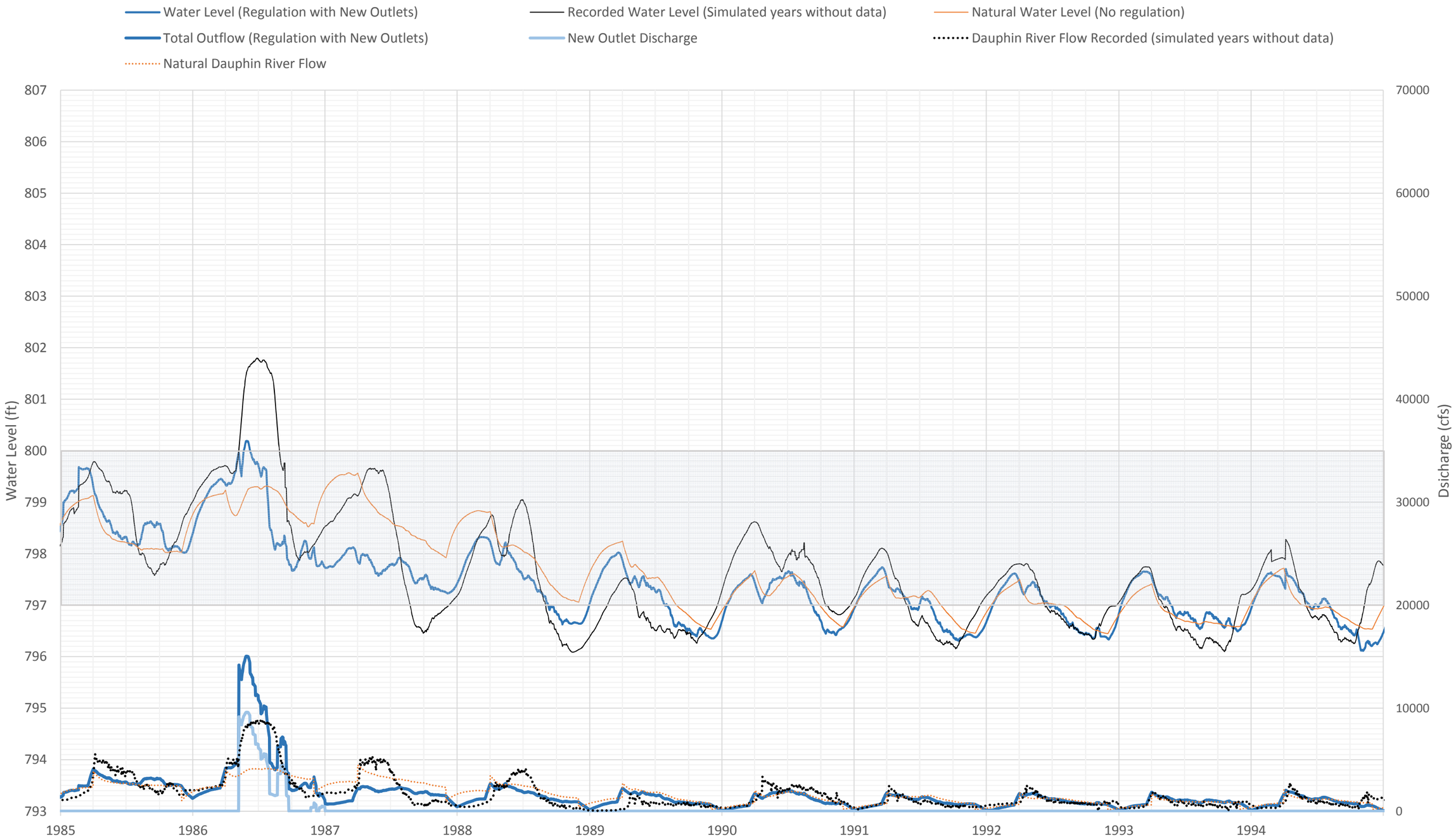
Lake St. Martin Water Levels and Outflows



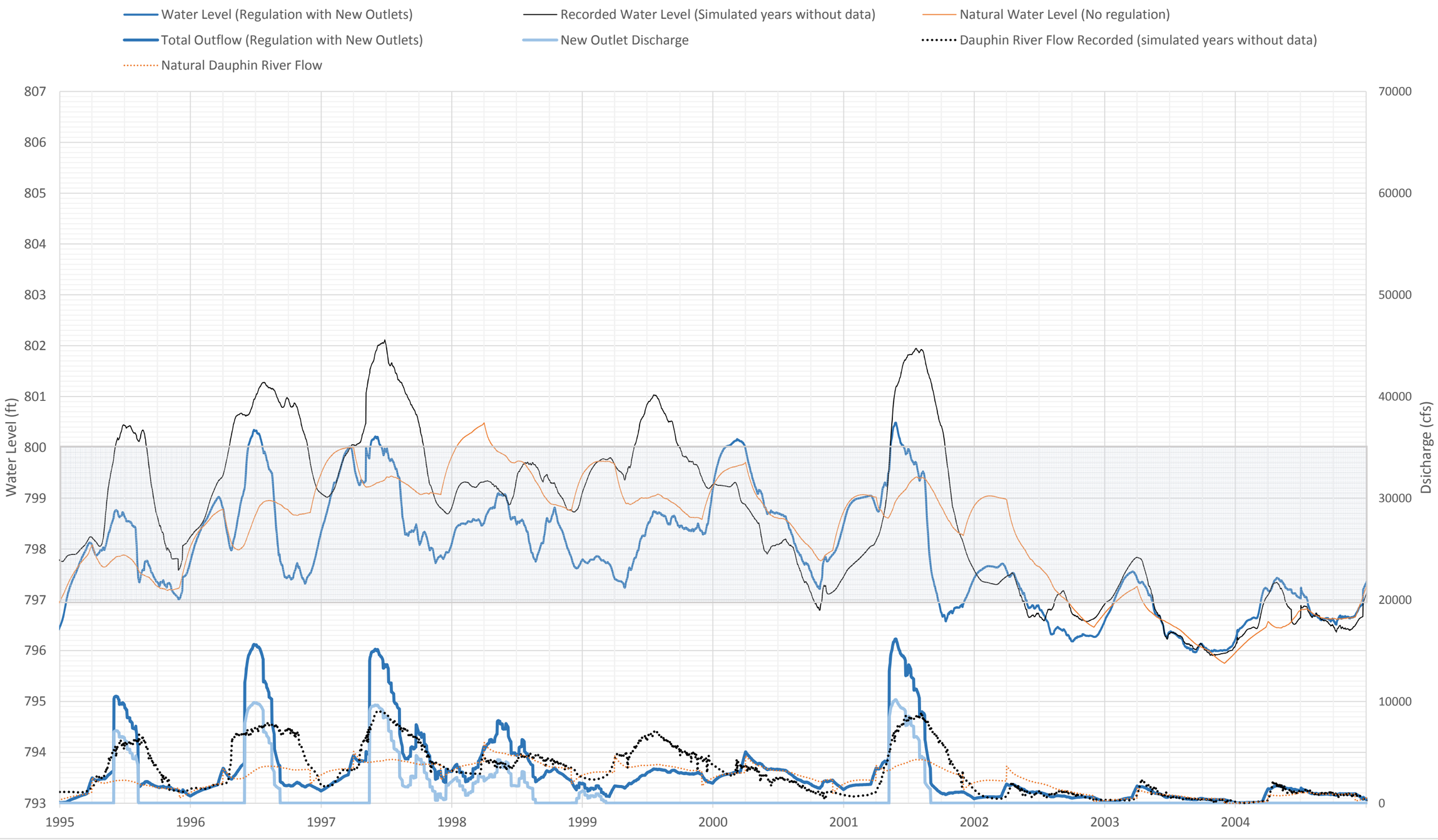
Lake St. Martin Water Levels and Outflows



Lake St. Martin Water Levels and Outflows



Lake St. Martin Water Levels and Outflows



Lake St. Martin Water Levels and Outflows