Appendix 6-F

Sutherland System General Operating Rules

Appendix 6-F contains the general operating rules for Sutherland Reservoir provided by Nebraska Public Power District staff. These general rules provided the framework for the calibration effort, with iterative adjustments to the operating rules and criteria made throughout calibration in concert with the Sponsor technical workgroup.

Technical Memo

Date:	September 2017
Project:	COHYST Stella Model
To:	File
From:	HDR
Subject:	Sutherland Reservoir Operating Rules

1.0 SUTHERLAND RESERVOIR

Korty Canal and Keystone Canal come together to form the Sutherland Canal, which provides inflow to the Sutherland Reservoir. The surface water model is setup to toggle between two different operating rules for the Sutherland Reservoir; (1) target minimum and target maximum elevations provided by NPPD (pre-October 2013), (2) minimum and target maximum operating curve provided by NPPD in October 2013. The model uses the operating rule with the set minimum and target operating curve provided by NPPD in October 2013.

The 2013 model used the first operating rule, where the reservoir level is maintained between a maximum and minimum target elevation which varies throughout the year. The releases from the reservoir are calculated to maintain reservoir levels between the target minimum and maximum levels. The target elevations are illustrated in **Figure 1**. **Figure 2** illustrates the target elevations with respect to the historical reservoir elevations for 1985 – 2005.

The historic reservoir levels illustrated in Figure 2 illustrate considerable year-to-year variability, especially outside of the June 15 – September 10 irrigation season.

The second Sutherland Reservoir operating rule uses a minimum threshold and target maximum operating curve provided by NPPD in October 2013. **Figure 3** compares the two operating rule limits. The second rule replaces the target minimum and maximum curves from the first rule with a flat minimum elevation (EL 3,045) and a variable maximum target operating curve. The maximum target operating curve operates between the previous (pre October 2013) minimum and maximum curves.

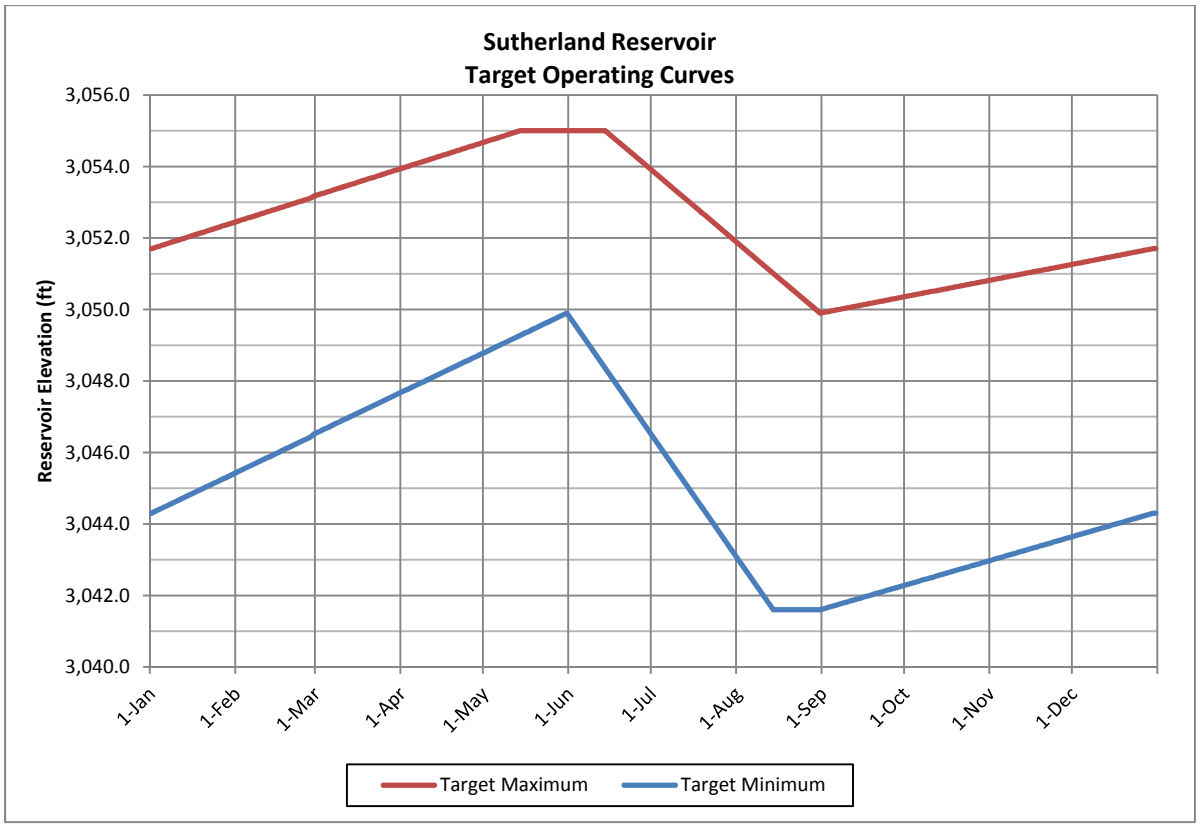

Figure 1. Sutherland Reservoir Operating Curve Limits.

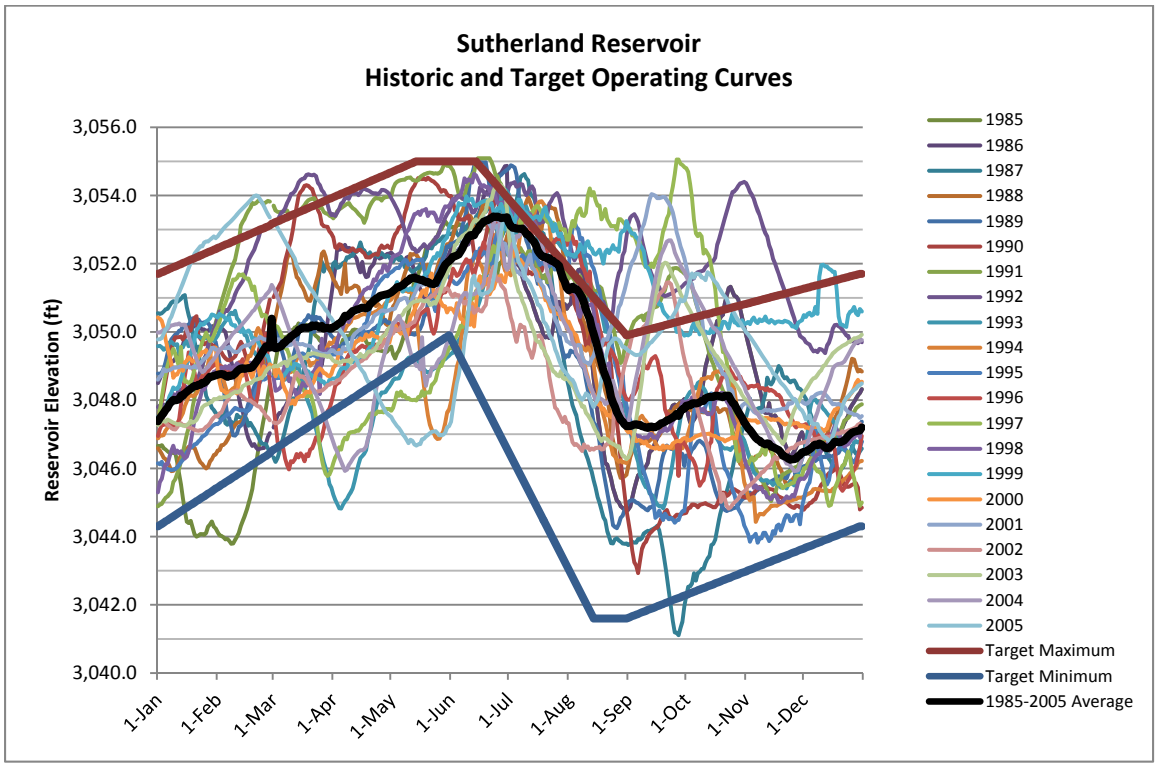

Figure 2. Sutherland Reservoir Operating Curve Limits and Historic Reservoir Levels.

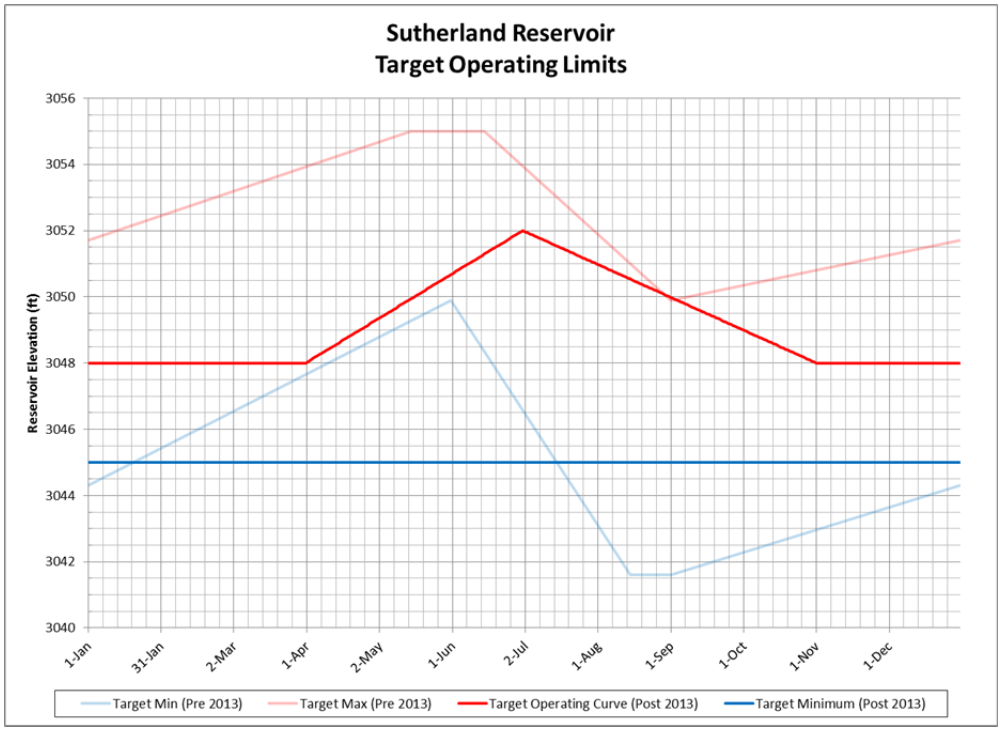

Figure 3. Sutherland Reservoir Operating Rule Comparison.

It is recognized that the post-2013 rule may not reflect historic operations, but better represents recent and future planned operations. **Figure 4** compares the October 2013 target operating curve to the historic reservoir elevations for 1990-1995. The figure shows the target operating curve provides a good estimate and matches the trends pretty well, but does not reach the historic minimums and maximums, as expected when using a target curve based on normal operating conditions.

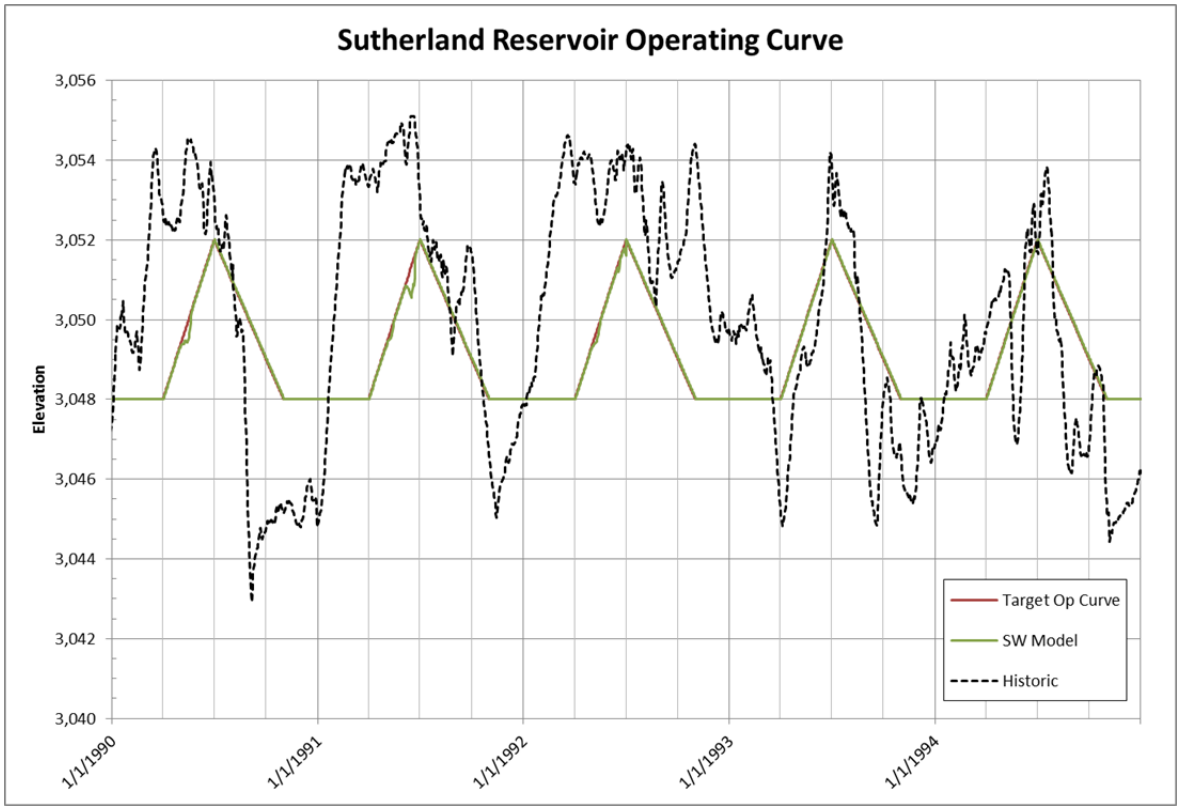

Figure 4.Sutherland Reservoir Target Operating vs. Historic Reservoir Elevations.

Sutherland Reservoir Operations

2013 Stella Model

Normal (Wet years) Operations:

During "normal" water years where reduced irrigations deliveries were not in place Sutherland reservoir was operated in a different manner than current practices. At the beginning of the spring the lake was filled to around elevation 3053-3054. As irrigation demands came up Sutherland was drawn down through out the summer usually ending the irrigation season in Sept around an elevation of 3045-3046. The lake was then filled back up to around elevation 3048-3049 and maintained there through out most of the winter until spring and then filled as noted above. Keep in mind that during these times water is running through the system year round.

Drought (Dry years) Operations:

During "dry" water years such as we have been experiencing since about 2002, Sutherland Reservoir is operated in a different manner. Due to reduced irrigation deliveries and GGS needing cooling water into late summer, Sutherland Reservoir is operated in a manner to accommodate GGS cooling water needs. Throughout late winter Sutherland will be allowed to draw down so that about the end of April it will be at elevation 3045. Throughout the spring, water will be ran (starting around mid April) to maintain Sutherland at elevation 3045 until GGS needs more flow for cooling (this will be dictated by weather conditions such as ambient temp, humidity and wind). As their cooling water needs increase the water will be accumulating in Sutherland until it is needed to be released for irrigation purposes, usually beginning to move water down to Maloney around the second week in May.

Sutherland elevations could vary depending on irrigation demand down stream and GGS cooling water needs. About the first week in July, flows will be at maximum going out of Sutherland (1600-1700) and around 1400 coming into Sutherland. Sutherland will be on a slow decline at this time. By the end of summer if irrigation demands drop off due to late season rains that are not uncommon, flows from Sutherland will decrease yet flow coming in will remain around 1400 for GGS. Sutherland will begin to fill again at this time. During 2007 the elevation made it to 3053 before weather broke and flows could be cut back. By mid Sept the system was shut down and Sutherland declined to around 3045 by Dec 1, we began running about 200 cfs into Sutherland through Dec and January shutting off in the first part of Feb after reaching an elevation of about 3050.5.

*Spring time operation can change depending on South Platte flows. If SP flows are realized early on that water will be used to charge the system, wetting the canals and filling Maloney to operating level. Any excess will be ran through and generated with at that time.