RS 44 – Wetlands Hydrology Study (baseline)

Wetland Hydrology Study Report 2006
PolyMet Mining Company
(RS-44)

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1.0 Objectives

On behalf of PolyMet Mining, Inc., Barr Engineering Company is submitting documentation of the second year of wetland hydrology monitoring including preliminary hydrology monitoring data, water elevation data, and climatic data for the proposed Northmet project. The monitoring study has primarily followed the protocols described in the June 24, 2005 *Wetland Hydrology Study Plan*. The objectives of the study are to:

1. Gain a better understanding of the wetland hydrology at the project site, i.e. defining whether specific wetlands are recharging the surficial deposits aquifer or are discharging to surface waters.
2. Collect baseline hydrology data that could be used to assess the effect of the project on wetland hydrology.
3. Review the data collected in the hydrogeologic study along with the wetland hydrology data to determine whether specific wetlands have perched water tables or are in direct hydrologic connection with the surficial deposits aquifer.
4. Determine the potential for indirect wetland impacts resulting from the project.

2.0 Methods

2.1 Well Placement

A total of 17 shallow, wetland monitoring wells were installed June 28-30, 2005. The remaining 3 standard monitoring wells (Wells 10, 11, and 18) were installed on October 25, 2005. The 4 recording wells were installed November 9-11, 2005. The location of the installed wells is shown on Figure 1 and the UTM coordinates for each are provided in Table 1. Photographs of the majority of the wells are provided in Appendix A.

The primary differences from the planned well locations shown on Figure 1 from the *Wetland Hydrology Study Plan* are in the relocation of Well 18 to the south and the addition of two wells (Wells 4 and 5) in the northwest corner of the project and the substitution of Well 4A in the place of the planned locations for Wells 4 and 5. The remainder of the wells were installed within the general proximity of the planned locations presented in the *Wetland Hydrology Study Plan*. A total of 11 monitoring locations are situated around the perimeter of the project and are not expected to be impacted by the project. The remaining 8 monitoring locations have the potential to be impacted by the project depending on the final mine and stockpile plans. Monitoring of these wells will continue in accordance with the planned study. If is determined, at some future time, that the wells are not providing useful information, then the monitoring may cease.

2.2 Well Construction and Installation

The standard wetland hydrology monitoring wells consist of an approximately 1.5 to 2.5-foot length of 1.25 inch diameter, 0.01” slot PVC commercial well screen wrapped with a filter sleeve, and threaded to a 1.0 to 2.5-foot riser. The well screens were typically installed to a depth of 1.5 to 2.5 feet below the ground surface (Table 1). A total of 4 recording wells were installed nearby Wells 1, 4, 7, and 12 to fill in water level data between monitoring events. The recording wells are Ecotone™ WM capacitance water level monitoring instruments manufactured by Remote Data Systems, Inc. The wells consist of a 20-inch, 1.5 inch diameter, 0.01” slot PVC commercial well screen with an approximately 14 inch riser.

All wells were backfilled with native soil, which was mounded at the surface to prevent water from preferentially infiltrating the annulus adjacent to the well. None of the wells were installed through a confining soil layer into a more permeable layer below. The soils encountered were typically peats and mucks, however sand was encountered in at least 6 wells and silt loam in 2 wells (Table 1). At least those 8 wells were installed into the mineral layer below the peat since it appeared that the layers were hydraulically connected. Each well was covered with a slip cap and a breather hole was installed near the top of the riser to equalize pressure. All wells were located with a Global Positioning System (GPS) with 3-meter accuracy immediately after installation; the locations are shown on Figure 1. The elevation of each well and the ground surface at the well were also surveyed to within approximately 0.1 ft. in December, 2005 and January, 2006 using a survey-grade GPS.

2.3 Water Level Recording

Water level measurements were recorded within each well, approximately once every two weeks from late April, 2006 through October, 2006. Typically, water levels were recorded in each standard well 13 times during the 2006 monitoring period. Frost action and shrinking and swelling of peat soils with fluctuation in water levels can affect elevation of recording wells. Therefore, the distance from the top of the well casing to the ground was measured during each monitoring event to ensure consistent measurement of the water level below the ground surface. The recording wells were set up to collect a water level reading every 2 hours during the monitoring period, which extended from November 11 through November 23, 2005 and April 27, 2006 through October 25, 2006. The recording wells are removed during the winter when water begins to freeze in the wells. The recording data was downloaded during each monitoring event.

3.0 Wetland Hydrology and Climatic Criteria

3.1 Wetland Hydrology Criteria

The minimum standard for an area to meet the technical wetland hydrology criteria in accordance with the *Army Corps of Engineers 1987 Wetland Delineation Manual* (1987 Manual) is to have soil saturation to the ground surface, or be inundated continuously in most years, for 5 percent of the growing season. According to the Natural Resources Conservation Service WETS data (statistical climate data for determining wetland hydrology), the normal growing season for the Babbitt area, based on the 1961-1985 climatic record, begins on May 9 and ends October 6, a total of 150 days.

These dates are determined from the methods in the 1987 Manual, which allows for estimating the starting and ending dates of the growing season based on the average first and last dates on which the air temperature drops to or rises above 28^0 F based on long-term temperature data. The 1987 Manual more precisely defines the growing season as the period when the soil temperatures exceed 40^o F at a depth of 20 inches. Based on the statistical growing season in Babbitt, the duration in which soils must be saturated to the surface or be inundated is about 7.5 days.

3.2 Normal Climatic Conditions

Hydrology studies to evaluate the presence or absence of wetland hydrology must also consider "climatic normalcy." The wetland hydrology criteria in the 1987 Manual states that soils must be saturated to the surface "in most years," which means in more than 50 percent of years. This definition acknowledges that some wetlands will not exhibit wetland hydrology in some years (typically years with below normal precipitation).

To evaluate and understand the wetland hydrology monitoring data; precipitation data during the monitoring period was collected and analyzed. The WETS precipitation statistics from the Babbitt National Weather Service (NWS) station were collected for the historic period 1961 to 1985 and used to determine precipitation normalcy during the study period (Table 4, Figures 2-11). Daily precipitation data was collected from the Babbitt NWS station and compared to Babbitt NWS WETS averages to determine climate normalcy during the 2005 and 2006 Water Years (defined as October 1 through September 30).

The data show that the 2005 water year was slightly above normal for annual precipitation following 3 straight years of annual precipitation below the normal range. The 2005 water year had equal months of precipitation below, within, and above the normal range. The two months during which the majority of the monitoring was conducted both experienced monthly precipitation above normal range. Due to the long, dry period leading up this study, it would be expected that all wetlands monitored may not exhibit their normal hydrologic regime.

Precipitation during the 2006 water year was at the low end of the normal range, or 2.46 inches below the average annual precipitation. Monthly precipitation during the 2006 water year was below the normal range in June, August and September, typically months with warm weather and high rates of evapotranspiration, which contributed to lower water levels. Monthly precipitation was above the normal range in three months early in the 2006 water year (November, February, and March), and one month in summer (July).

4.0 Monitoring Schedule

Monitoring began shortly before the beginning of the statistical start of the growing season, in late April, 2006. Water levels were typically measured in each well once every two weeks from April 26, 2006 until October 25, 2006.

5.0 Results

5.1 General Site Hydrology

The PolyMet site is bordered on three sides by the Partridge River. The proposed mine site lie on the north side of the Dunka Road. There is a drainage divide oriented generally from southwest to northeast near the northern border of the site (Figure 1). The majority of the mine site (80 percent) drains south through culverts under the Dunka Road and on to the Partridge River through extensive wetland complexes. The remaining 20 percent of the mine site drains north to the Hundred Mile Swamp and the Partridge River or northeast to the Partridge River (Figure 1). Exploratory borings generally indicate that the bedrock surface slopes down from north to south between the north side of the proposed mine site and the Dunka Road (Figure 12).

5.2 Soil Characteristics

The soils on the site have formed in the coarse-textured till, and a much denser till lies about 40 inches below the surface according to the U.S. Forest Service Ecological Land Type classifications for the site. Because of the dense underlying till, most of the mineral soils in the depressional and flat-bottom areas of the landscape experience perched water tables during late spring and early summer at a depth of 1 to 3 feet. The majority of the extensive wetland complexes on and adjacent to the site are mapped as *ELT 6--LPN-Lowland Organic Acid to Neutral* which is equivalent to the Rifle mucky peat and Greenwood peat mapping units in the Natural Resources Conservation Service soil survey system. These soils are typically characterized by having fibric peat in the upper horizons underlain by mucky peat to a depth of up to 5 feet or more.

The Hundred Mile Swamp wetland is an extensive flat peatland with an average slope of about 0.2 percent from west to east (Figure 1). On average, wetlands make up 43 percent of the watershed areas within the main part of the mine site. Within the detailed watersheds shown on Figure 1, wetlands make up 32 percent to 56 percent of the land area within each watershed. In the wetland areas located within and north of the proposed mine site (where soil boring data is available), the surficial soils and quaternary deposits generally range from 1 to 25 feet thick. Many of the areas have clayey till underlying the organic soils in the wetlands and bedrock fairly close to the surface. However, the site is highly variable and sand to silty sand deposits are present in some areas, with bedrock at greater depths (Appendix B). The soils within the upland areas are primarily mapped as shallow, loamy dry soils, typically 20 to 40 inches thick, underlain by bedrock (Appendix C).

It appears that the hydrology in the wetlands on the site is characterized by a waterlogged organic soil body perched over the dense till or a more localized sandy surficial aquifer. Lateral subsurface flow within peatland soils on extensive flat peatlands is typically very slow to negligible. Surface runoff from these flat peatlands is also generally negligible except during snowmelt, due to the high water-holding capacity of the peat, the flat slopes, and the surface roughness.

Surface runoff from the upland areas to the wetlands does not appear to be prevalent due to the loamy soils and healthy forest soil structure. As indicated in the Superior National Forest Ecological Classification System (Appendix C), the upland soils yield water to the lower landscape positions mainly through flowage along the soil-bedrock interface. It appears that the wetlands are supported primarily by direct precipitation and subsurface flow from the relatively small watershed areas with shallow local ground water flow making up a more variable component. This setting is fairly typical of northern Minnesota where evapotranspiration is considerably less than in warmer climates with longer growing seasons.

5.3 Wetland Hydrology

The wetland water level data in relationship to the ground surface are shown graphically on Figures 2-6 and in a tabular format in Table 2. The data for wells in similar areas of the study are grouped together on each figure. The areas presented include:

1. Southwest mine site including Wells 6, 7, and 19 (Figure 2),
2. Northwest mine site including Wells 3, 4, 5, and 17 (Figure 3),
3. North-central mine site including Wells 2, 10, 11, 12, and 18 (Figure 4),
4. South-central mine site including Wells 1, 8, and 9 (Figure 5), and
5. Northeast mine site including Wells 13, 14, 15, and 16 (Figure 6).

The monitoring data obtained between April 25, 2006 and October 25, 2006 shows the presence of sustained wetland hydrology (within 12 inches of the ground surface) in the majority of the monitored wetlands throughout the entire monitoring period (Table 2). Water levels in the group of wells located in the large wetland complex in the north-central part of the mine site (Wells, 2, 10, 11, 12, and 18, Figure 4) dropped to about 15 inches below the ground surface from early July through late October, with the exception of Well 12, which had sustained water levels within 12 inches of the ground surface. This drop in water levels followed a sustained period of over one month with precipitation well below the normal range (Figure 4). Water levels in the two wells (Wells 13 and 14), located northeast of the mine site dropped to between 18 and 20 inches below the ground surface in the middle of June 2006 and stayed at that level until the water levels started to recover in October. These wetlands are located close to the Partridge River and the hydrologic regime appears to be more responsive to drought conditions due to the proximity to the river. The only other well in which water levels dropped to lower than 12 inches below the ground surface in 2006 was Well 19 (Wetland 15). Water levels in Well 19 dropped to just under 12 inches below the ground surface in early September, but rebounded in early October. Wetland 15 is located at the upstream end of a larger wetland complex and is therefore, the hydrologic regime is tied more closely to climatic fluctuations.

Continuous water level recording wells were monitored in duplicate at well locations 1, 4, 7, and 12 (Figures 2-5). Water levels were recorded once every 2 hours during the monitoring period, with the exception of Well 7M, in which, the battery died in the middle of June, and was not repaired until early August. While the recording well data is helpful in understanding the response of hydrology to specific storm events, at the mine site, it is not necessary for documenting whether or not jurisdictional wetland hydrology is present, since it is clearly present in all wetlands monitored. The recording well data for Wells 4M and 12M, located within the Hundred Mile Swamp complex, indicates very stable hydrology with limited direct response to precipitation events (Figures 3, 4, and 12). This response is indicative of a large, headwater wetland complex with very little contributing watershed area. Recording well data for Wells 1M and 7M show greater response to precipitation due to the larger contributing watersheds and throughflow from upstream watersheds (Figures 2, 5, and 12).

In general, the hydrologic regime of the wetlands at the mine site are characterized by sustained, stable water levels maintained within the upper 12 inches of the ground surface with periods of shallow inundation (2-3 inches). The wetland hydrology observed at the mine site appears to be indicative of a system supported by a stable groundwater system that is not sensitive to climatic fluctuations. Precipitation patterns during 2006 were highly variable. Precipitation was below the normal range for a total of about three months during 2006 (Figures 2-6). There were also several spikes when precipitation was above the normal range, however, these periods were short-lived and generally resulted from single storm events (Figures 2-6). There were a total of 4 storm events during 2006 with over 1 inch of precipitation, all occurring between July 3 and August 14. The largest event was 1.76 inches of rainfall on August 13-14, 2006.

A 30-day pumping test was conducted starting October 19, 2006 to address the relationship between the wetlands, the surficial deposits aquifer, and the bedrock aquifer. The pumping test well was located in the upland area located south of Well 2 (Wetland 100). The response of water levels in the wetlands to the pumping test was monitored in a series of nested piezometers. Existing Wells 2 and 12 were used for this purpose and an additional location (Well 20) was established near the edge of Wetland 100, south of Well 2. At the location of Wells 2 and 20, one shallow well (screened in the upper 2 feet of the ground surface) and one piezometer (screened at 5-6 feet below the ground surface) were installed to monitor the response to the pumping test. Continuous recording data loggers were installed in the wells and piezometers and were operated starting approximately 10 days prior to starting the test and continued until after pumping ceased. The results of the pumping test are not yet available, but will be discussed in the *Phase III Hydrogeologic Investigation* report.

5.4 Wetland Hydrology Elevations

The average water level elevations recorded in the wetland monitoring wells in 2005-2006 along with the ground elevations at each well are shown spatially on Figure 1. The water level elevation data is also shown graphically by project area on Figures 7-11. The wetland water level elevations are shown in tabular format on Table 3. The average wetland water elevations around the project site range from 1558.0 ft. MSL south of the Dunka Road at Well 7 to 1615.7 ft. MSL in the northwest corner of the mine site (in the Hundred Mile Swamp) at Wells 4 and 5 (Figure 1). The water table gradient throughout the site is very flat, ranging from 0.05 percent to 1.2 percent. The steepest gradient observed is between Wells 2 and 12, near the Partridge River. The water table gradient is 1.2 percent, sloped toward the river, based on the average water levels recorded in 2006. In the headwaters of the Partridge River, between Wells 5 and 4A, the water gradient during 2006 was 0.6 percent, also sloped toward the river. The average water table slope between Wells 2, 11, and 18 is about 0.1 percent sloping downward to the southwest. The average water table slope between Wells 3 and 7 is about 0.8 percent sloping downward to the south.

6.0 Discussion

6.1 Hydrogeologic Conditions

Nested piezometers were installed in at the locations of Wells 2 and 20 as part of the pumping test that is currently nearing completion. It is expected that monitoring data from those wells will provide an indication of the relationship of the wetland hydrology to the surficial deposits aquifer. The results of the pumping test will be presented in the *Phase III Hydrogeologic Investigation* report.

6.2 Baseline Hydrology

The preliminary data show the presence of stable wetland hydrology within the project area. The wetlands within the project site could be characterized as a large, interconnected wetland complex with intermixed upland areas of relatively low relief. The stability of the hydrology is likely due to several factors:

1. The predominance of peat soils with high water-holding capacity,
2. Flat slopes and high surface roughness, which minimize surface runoff,
3. The presence of dense clayey till or shallow bedrock, which prevent seepage losses, and
4. Loamy upland soils that do not produce significant surface runoff, but result in shallow, subsurface discharge to the wetlands.

Wetland hydrology monitoring will continue, as warranted, during the permitting process, development of the mine, and the mine operating period. This data will present a complete picture of the wetland hydrology at the project site.

In general, the wetland water level elevations are fairly consistent within the wetland complexes oriented from the southwest to the northeast. This is evident in looking at the series of wells along an imaginary transect in the southern portion of the project, including Wells 19, 1, and 16. The water levels along this transect were all within 0.1 ft. of one another during 2006, ranging from 1586.1 to 1586.2 ft. MSL (Figure 1). Wetland water levels within an imaginary transect extending through Wells 17, 3, 18, 11, and 2 along the northern part of the project area are fairly consistent, ranging from 1595.5 to 1600.5 ft. MSL across a span of a little over 2 miles (Figure 1). Finally, the wetland water levels along an imaginary transect located south of the Dunka Road through Wells 7, 8, and 9 show a slight gradient (0.07 percent) from northeast to southwest, ranging from 1558.0 to 1565.7 ft. MSL (Figure 1). Monitored wetlands located closer to the Partridge River show a slightly more pronounced hydraulic gradient toward the river, but still fairly flat.

7.0 Future Actions

The wetland hydrology monitoring will continue in 2007 on a biweekly basis from approximately May 1, 2007 until September 1, 2007 and then monthly until about December 1, 2007, if warranted. Alternatively, the continuous data obtained from the four recording wells may provide sufficient data to document the hydroperiod of the main wetlands surrounding the project site so that biweekly monitoring would not be needed. Additional piezometers could be installed in 2007 and included in the monitoring protocols to further evaluate the relationship of wetland hydrology to the surficial deposits aquifer, should insufficient information be obtained from the current hydrogeologic investigation.

Table 1
2006 Wetland Monitoring Well Summary
PolyMet Mining
Hoyt Lakes, Minnesota

Well ID	Wetland ID	Circ 39 Type	Date Installed	2005 Average Depth to Water[3]	2005 Average Water Elevation (ft MSL)	2006 Average Depth to Water[3] (in)	2006 Water Elevation (ft MSL)	UTM Coordinates		Top of Casing to Ground (inches)	Top of Casing Elevation (ft. MSL)	Ground Elevation (ft MSL)	Well Length (inches)	Below Ground Length (inches)	Stratigraphy Notes	Installer[1]
								X:	Y:							
Well #1	48	8	6/28/2005	0.00	1586.43	3.60	1586.13	577670	5273982	10	1587.26	1586.43	29	19	4" peat above 16" mucky peat	MAJ
Well #1M	48	8	11/9/2005	0.50	1586.38	-3.31	1586.70	577669	5273984	6.5	1587.0	1586.43	33.75	27.25		NTS
Well #2	100	8	6/30/2005	11.25	1600.74	14.56	1600.47	578291	5275294	23	1603.60	1601.68	59.5	36.5		MEW
Well #3	103	8	6/29/2005	0.44	1596.98	2.17	1596.84	576018	5274075	13.5	1598.15	1597.02	29	15.5		MEW
Well #4	114	8	6/28/2005	-0.92	1615.65	-2.23	1615.76	574918	5274129	13.5	1616.70	1615.57	28.75	15.25	15" peat	MEW
Well #4M	114	8	11/9/2005	-1.38	1615.69	-0.09	1615.58	574920	5274138	6.5	1616.1	1615.57	33.75	27.25		NTS
Well #4A	114	8	6/29/2005	2.65	1597.85	1.06	1597.98	575669	5274600	11.5	1599.03	1598.07	29	17.5		MEW
Well #5	114	8	6/28/2005	-1.17	1615.60	-1.40	1615.62	574918	5274129	12.5	1616.55	1615.51	29	16.5	15" peat	MEW
Well #6	54	6	6/29/2005	0.96	1597.79	0.42	1597.83	574794	5272347	29	1600.28	1597.87	59.5	30.5	3" peat, 25" fine sand	MEW
Well #7	53	6	6/29/2005	-1.25	1558.37	2.65	1558.05	576323	5272608	26	1560.43	1558.27	59.25	33.25		MEW
Well #7M	53	6	11/9/2005	0.73	1558.21	3.46	1557.98	576312	5272607	6.5	1558.8	1558.27	33.75	27.25		NTS
Well #8	106	8	6/30/2005	0.10	1564.11	4.10	1563.78	578657	5273785	29	1566.54	1564.12	59.25	30.25	8"peat, 12" fine muck (compacted), 8" sand	MEW
Well #9	58	6	6/30/2005	0.11	1565.84	1.62	1565.72	579257	5274041	28	1568.18	1565.85	59.5	31.5	14" peat, 4" muck, 10" sand	MEW
Well #10	100	8	10/25/2005	12.56	1598.33	12.06	1598.37	577169	5275313	5	1599.79	1599.38	28.75	23.75	mucky peat	MEW/NTS
Well #11	100	8	10/25/2005	9.00	1597.40	11.46	1597.19	577610	5274975	12	1599.15	1598.15	28.75	16.75	mucky peat	MEW/NTS
Well #12	100	8	6/30/2005	3.60	1592.38	7.00	1592.10	578188	5275487	24.5	1594.72	1592.68	59.5	35	14" peat, 4" muck, 10" sand	MEW
Well #12M	100	8		-0.40	1592.71	9.11	1591.92			5.5	1593.1	1592.68	33.75	28.25		NTS
Well #13	84	8	6/29/2005	17.54	1578.73	7.00	1579.60	580022	5275659	8	1580.85	1580.19	29	21	6" sphagnum peat, 10" mucky peat, 5" mucky silt loam	MAJ
Well #14	90	8	6/29/2005	13.90	1574.32	14.17	1574.30	580480	5275406	8	1576.15	1575.48	29	21	4" sphagnum peat, 8" black and dark brown muck w/silt loam, 9" reddish peat	MAJ
Well #15	83	8	6/29/2005	7.54	1572.18	7.54	1572.18	580790	5274950	6.5	1573.35	1572.81	29	22.5	21" mucky peat w/ some sand, 2+" sand	MAJ
Well #16	90	8	6/30/2005	3.88	1586.20	3.60	1586.23	579201	5274883	27	1588.78	1586.53	59.75	32.75		MEW
Well #17	103	8	6/29/2005	1.75	1599.25	3.21	1599.12	575812	5273791	13	1600.48	1599.39	29	16		MEW
Well #18	100	8	10/25/2005	12.69	1595.37	10.90	1595.52	577100	5274700	6	1596.93	1596.43	28.5	22.5	peat	MEW/NTS
Well #19	15	8	6/28/2005	1.85	1586.38	4.79	1586.13	575729	5272919	29	1588.95	1586.53	59.68	30.68	8" peat, 18" 10YR6/1 sand	MEW
722057	15	8		3.50				578258	5273824	47	1590.45	1586.53	233	186	48" silty sand, 120" sand, 60" silty sand, 110" silty clay	

[1] MAJ = Mark Jacobson, Barr Engineering; MEW = Mark Wilson, Barr Engineering; NTS = Rick Setimi, Northeast Technical Services

[2] Top of casing elevation is approximate, the top of the cap was surveyed and not the top of well casing.

[3] Positive numbers represent depth below ground and negative numbers represent flooding.

Table 2
2005 and 2006 Wetland Hydrology Monitoring Data
PolyMet Mining
Hoyt Lakes, Minnesota

Date	06/28/05	06/29/05	06/30/05	10/18/05	10/25/05	11/09/05	11/10/05	11/11/05	11/15/05	11/17/05	11/18/05	11/21/05	11/22/05	11/23/05	11/28/05	11/29/05
Precipitation (in.)[1]	**2.50**	**0.00**	**0.86**	**8.19**	**0.53**	**0.41**	**0.22**	**0.00**	**0.94**	**0.11**	**0.00**	**0.20**	**0.12**	**0.00**	**0.20**	**1.28**
Well No.	**Depth to Water (inches)[2]**															
1	0.00			0.50		1.00			-1.00					-0.50		
1R									-0.25					3.00		
2			10.50		14.25		12.00		11.50					10.50		8.75
3		0.00			1.00			0.50				0.25				
4	-3.00				0.00	0.00			-1.00					-0.50	-1.00	
4R									1.50					0.50		
4A		2.00			3.00			3.00	2.00			3.25				
5	-7.50				0.00	1.00			-0.50					0.25	-0.25	
6		4.50		0.10			-0.50					-0.25				
7		-2.25		-0.50		0.00			-2.25							
7R									3.75					5.25		
8			-2.25	1.60			2.00				-0.25	-0.50			0.00	
9			-1.00	0.92			1.25				0.00		-0.25		-0.25	
10					19.50			13.00			8.75		9.00			
11					11.50		11.00				6.50		7.00			
12			0.50		5.00		4.75							5.00		2.75
12R														13.00		
13		21.00		21.00			13.00			18.00		16.50			15.75	
14		18.75		15.40			20.25			9.50		10.00			9.50	
15		7.50		9.22			7.75			6.75		7.25			6.75	
16			2.75	1.50				1.25			6.00		6.50			5.25
17		0.50			2.00			2.50				2.00				
18					22.00			11.75			8.00	9.00				
19	5.18			1.75	2.00	2.00					0.50			1.00	0.50	
722057					3.50											

[1] Cumulative precipitation between sampling events (except 6/28/05 and 4/25/06 includes previous 2 weeks).

[2] Negative values represent inundation above the ground surface.

Days on which precip accumulated in the gage are shown as '-'. Precipitation is recorded in the next reading.

Table 2
2005 and 2006 Wetland Hydrology Monitoring Data
PolyMet Mining
Hoyt Lakes, Minnesota

Date	04/25/06	04/26/06	04/27/06	05/08/06	05/09/06	05/10/06	05/22/06	05/23/06	05/24/06	06/07/06	06/08/06	06/09/06	6/19/2006	6/20/2006	6/21/2006	7/12/2006
Precipitation (in.)[1]	**0.67**	**0.00**	**0.00**	**0.36**	**0.35**	**0.42**	**1.44**	**0.00**	**0.00**	**2.17**	**0**	**0**	**0.28**	**0**	**T**	**2.01**
Well No.																
1			-1.75			-5.50			-2.50		-3.00				-0.25	
1R			0.25			-4.30			-6.60		-5.90				-8.10	
2		10.50			9.50			11.00				10.50		13.00		
3			-0.25			-2.25			-1.00		-1.50				1.25	
4			0.00			-2.50			-0.25		-1.50					
4R			-0.50													
4A			-1.50			-3.25			-2.00		-2.50				-1.00	
5			-3.00			-5.25			-3.50		-4.50				-2.75	
6		-5.25			-1.75			-2.25				-2.25		-1.50		2.50
7		-2.00				-4.25		-2.00				-1.50		1.75		
7R																
8	-1.25			-0.50			-0.75			-1.75			2.75			4.50
9		-2.25			-2.50			-3.00				-3.25		-0.25		2.25
10		7.25			7.25			7.75				7.50		10.50		
11		5.75			5.75			6.50				6.50		10.00		
12		2.25			1.00			1.75				1.50		5.25		
12R					14.25											
13	4.75			5.50			5.75			5.75			8.75			
14	7.00			8.25			8.25			7.75			14.25			16.75
15	3.75			4.50			4.50			4.25			6.50			9.50
16	-1.00			0.25			-0.50			-0.25			2.00			5.00
17		0.25				-3.25			-2.00		-1.50				1.00	
18		5.25			3.50			6.00				5.50		9.25		
19			-1.25			-3.00			-1.75		-2.25				-0.50	
722057																

Table 2
2005 and 2006 Wetland Hydrology Monitoring Data
PolyMet Mining
Hoyt Lakes, Minnesota

Date	7/13/2006	7/14/2006	7/24/2006	7/25/2006	7/27/2006	8/7/2006	8/8/2006	8/9/2006	8/22/2006	8/23/2006	8/24/2006	9/11/2006	9/12/2006	9/13/2006
Precipitation (in.)[1]	**-**	**-**	**1.49**	**-**	**-**	**1.58**	**-**	**-**	**1.8**	**-**	**-**	**0.92**	**0.00**	**0.00**
Well No.														
1		6.25			13.75			11.00			5.25			12.50
1R		-13.50			-21.00			11.00			-10.30			-18.40
2		19.25		20.25			17.25			14.25			17.25	
3	3.75				5.50			6.25			4.50			6.00
4	2.50				4.75			5.00			3.50			5.50
4R														
4A	2.00				4.25			4.50			2.50			4.00
5	-1.25				0.75			1.00			-0.50			1.50
6			5.25			10.00			-1.25			1.75		
7	3.50				5.75		6.00			5.00			10.00	
7R					4.50									
8			6.75				7.25		7.50				9.00	
9			5.25				5.75			3.50			5.25	
10		13.75		16.25		14.50			13.75			15.25		
11		13.00		16.25		14.75			13.75			14.50		
12		11.50		12.50			10.50			6.50			9.00	
12R														
13														
14			19.00			18.00			17.25			18.00		
15			12.50			9.00			8.00			9.75		
16			6.75				7.50			5.50			7.00	
17	4.50				6.25			6.75			5.25			7.00
18		12.50		15.50		14.00			13.25			15.00		
19	4.50				7.50			7.00			5.00			13.00
722057														

Table 2
2005 and 2006 Wetland Hydrology Monitoring Data
PolyMet Mining
Hoyt Lakes, Minnesota

Date	9/25/2006	9/26/2006	9/27/2006	10/9/2006	10/10/2006	10/11/2006	10/23/2006	10/24/2006	10/25/2006
Precipitation (in.)[1]	**1.21**	**-**	**-**	**0.68**	**-**	**-**	**1.30**	**-**	**-**
Well No.									
1			5.50			4.50			1.00
1R			-11.80			-11.00			-8.30
2		16.00				16.00		14.50	
3			5.25		1.25				-0.50
4			3.75		4.00				2.00
4R									
4A			3.00		2.75				1.00
5			0.25		0.50				-1.50
6	0.75			1.00			-1.50		
7		4.50			5.25			2.50	
7R									
8		8.00				6.75		5.00	
9		4.75				3.50		2.00	
10	15.00			14.75			13.25		
11	14.25			14.50			13.50		
12		8.50				12.00		8.75	
12R									
13				10.00			8.50		
14	17.00			17.25			15.50		
15	9.50			9.00			7.25		
16		6.00				5.00		3.50	
17			6.25		6.50				4.75
18	14.25			14.75			13.00		
19			12.00		12.50				9.50
722057									

Table 3
2005 and 2006 Wetland Hydrology Elevation Data
PolyMet Mining
Hoyt Lakes, Minnesota

Date			2005	2005	2005	6/28/2005	6/29/2005	6/30/2005	10/18/2005	10/25/2005	11/9/2005	11/10/2005	11/11/2005	11/15/2005	11/17/2005	11/18/2005	11/21/2005	11/22/2005	11/23/2005	11/28/2005	11/29/2005
Cumulative Precipitation (inches)[1]						**2.50**	**0.00**	**0.86**	**8.19**	**0.53**	**0.41**	**0.22**	**0.00**	**0.94**	**0.11**	**0.00**	**0.20**	**0.12**	**0.00**	**0.20**	**1.28**
Well No.	Ground Elevation (ft. MSL)	Well Bottom Elevation (ft. MSL)	Average Water Elevation (ft. MSL)	n	Range (ft)	**Water Elevation (ft. MSL)**															
1	1586.43	1584.8	1586.4	5	0.17	1586.43			1586.38		1586.34			1586.51					1586.47		
1M	1586.43	1584.2	1586.3	2	0.27									1586.45					1586.18		
2	1601.68	1598.6	1600.7	6	0.46			1600.81		1600.49		1600.68		1600.72					1600.81		1600.95
3	1597.02	1595.7	1597.0	4	0.08		1597.02			1596.94			1596.98				1597.00				
4	1615.57	1614.3	1615.7	6	0.25	1615.82				1615.57	1615.57			1615.66					1615.62	1615.66	
4M	1615.57	1613.3	1615.5	2	0.08									1615.45					1615.53		
4A	1598.07	1596.6	1597.8	5	0.10		1597.90			1597.82			1597.82	1597.90			1597.80				
5	1615.51	1614.1	1615.5	6	0.33	1615.76				1615.51	1615.42			1615.55					1615.49	1615.53	
6	1597.87	1595.3	1597.8	4	0.42		1597.49		1597.86			1597.91					1597.89				
7	1558.27	1555.5	1558.4	4	0.19		1558.45		1558.31		1558.27			1558.45							
7M	1558.27	1556.0	1557.9	2	0.13									1557.95					1557.83		
8	1564.12	1561.6	1564.1	6	0.35			1564.31	1563.99			1563.95				1564.14	1564.16			1564.12	
9	1565.85	1563.2	1565.8	6	0.19			1565.93	1565.77			1565.75				1565.85		1565.87		1565.87	
10	1599.38	1597.4	1598.3	4	0.90					1597.75			1598.29			1598.65		1598.63			
11	1598.15	1596.8	1597.4	4	0.42					1597.19		1597.23				1597.60		1597.56			
12	1592.68	1589.8	1592.4	5	0.38			1592.64		1592.26		1592.28							1592.26		1592.45
12M	1592.68	1590.3	1591.6	1	0.00														1591.60		
13	1580.19	1578.4	1578.7	6	0.67		1578.44		1578.44			1579.10			1578.69		1578.81			1578.88	
14	1575.48	1573.7	1574.3	6	0.90		1573.92		1574.20			1573.79			1574.69		1574.65			1574.69	
15	1572.81	1570.9	1572.2	6	0.21		1572.18		1572.04			1572.16			1572.25		1572.21			1572.25	
16	1586.53	1583.8	1586.2	6	0.44			1586.30	1586.40				1586.42			1586.03		1585.98			1586.09
17	1599.39	1598.1	1599.2	4	0.17		1599.35			1599.23			1599.18				1599.23				
18	1596.43	1594.6	1595.4	4	1.17					1594.59			1595.45			1595.76	1595.68				
19	1586.53	1581.6	1586.4	7	0.39	1586.10			1586.38	1586.36	1586.36					1586.49			1586.45	1586.49	
722057	1586.53	1571.03	1586.24	1						1586.24											

[1] Cumulative precipitation between sampling events (except 6/28/05 and 4/25/06 includes previous 2 weeks).
Days on which precip accumulated in the gage are shown as '-'. Precipitation is recorded in the next reading.

Table 3
2005 and 2006 Wetland Hydrology Elevation Data
PolyMet Mining
Hoyt Lakes, Minnesota

Date	2006	2006	2006	4/25/06	4/26/06	4/27/06	5/8/2006	5/9/2006	5/10/2006	5/22/2006	5/23/2006	5/24/2006	6/7/2006	6/8/2006	6/9/2006	6/19/2006	6/20/2006	6/21/2006	7/12/2006	7/13/2006	7/14/2006
Cumulative Precipitation (inches)[1]				0.67	0.00	0.00	0.36	0.35	0.42	1.44	0.00	0.00	2.17	0.00	0.00	0.28	0.00	T	2.01	-	-
Well No.	Average Water Elevation (ft. MSL)	n	Range (ft)	Water Elevation (ft. MSL)																	
1	1586.1	13	1.60			1586.57			1586.88			1586.63		1586.68				1586.45			1585.91
1M	1586.7	2172	1.66			1586.41			1586.78			1586.98		1586.92				1587.10			1587.55
2	1600.5	13	0.90		1600.81			1600.89			1600.77				1600.81		1600.60				1600.08
3	1596.8	13	0.71			1597.04			1597.21			1597.10		1597.15				1596.92		1596.71	
4	1615.4	12	0.67			1615.57			1615.78			1615.60		1615.70						1615.37	
4M	1615.6	2170	0.67			1615.62															
4A	1598.0	13	0.65			1598.19			1598.34			1598.24		1598.28				1598.15		1597.90	
5	1615.6	13	0.56			1615.76			1615.94			1615.80		1615.88				1615.74		1615.61	
6	1597.8	13	1.27		1598.31			1598.01			1598.06				1598.06		1597.99		1597.66		
7	1558.0	13	1.19		1558.43				1558.62		1558.43				1558.39		1558.12			1557.98	
7M	1558.0	1646	1.26																		
8	1563.8	13	0.90	1564.22			1564.16			1564.18			1564.27			1563.89			1563.74		
9	1565.7	13	0.75		1566.04			1566.06			1566.10				1566.12		1565.87		1565.66		
10	1598.4	13	0.75		1598.77			1598.77			1598.73				1598.75		1598.50				1598.23
11	1597.2	13	0.88		1597.67			1597.67			1597.60				1597.60		1597.31				1597.06
12	1592.1	13	0.96		1592.49			1592.60			1592.53				1592.55		1592.24				1591.72
12M	1591.9	2024	0.83		1590.89			1591.49													
13	1579.6	7	0.44	1579.79			1579.73			1579.71			1579.71			1579.46					
14	1574.3	13	1.00	1574.90			1574.79			1574.79			1574.83			1574.29			1574.08		
15	1572.2	13	0.73	1572.50			1572.43			1572.43			1572.46			1572.27			1572.02		
16	1586.2	13	0.71	1586.61			1586.50			1586.57			1586.55			1586.36			1586.11		
17	1599.1	13	0.85		1599.37				1599.66			1599.56		1599.52				1599.31		1599.02	
18	1595.5	13	1.00		1595.99			1596.13			1595.93				1595.97		1595.65				1595.38
19	1586.1	13	1.33			1586.55			1586.78			1586.68		1586.72				1586.57		1586.16	
722057																					

Table 3
2005 and 2006 Wetland Hydrology Elevation Data
PolyMet Mining
Hoyt Lakes, Minnesota

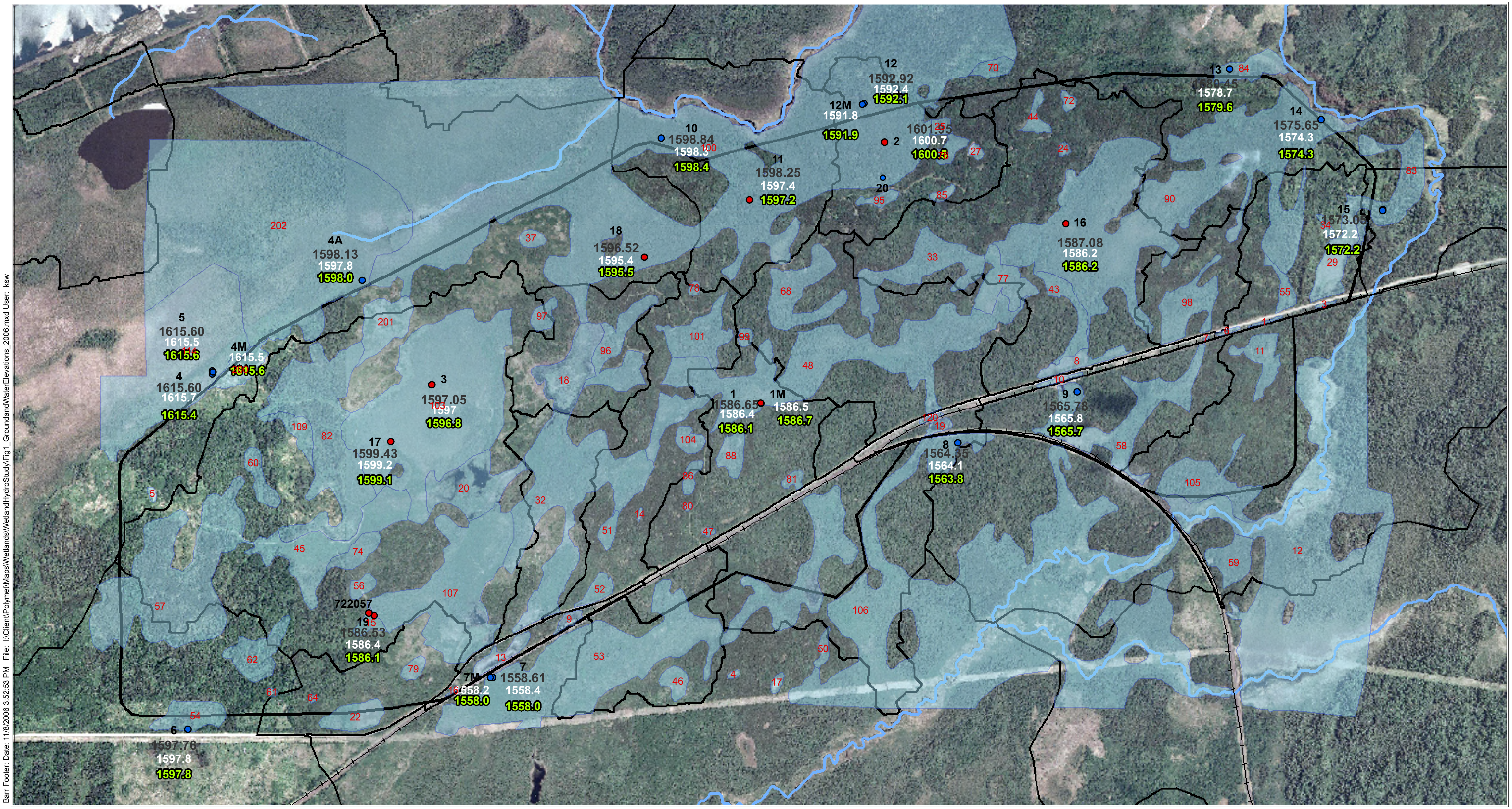
Date	7/24/2006	7/25/2006	7/27/2006	8/7/2006	8/8/2006	8/9/2006	8/22/2006	8/23/2006	8/24/2006	9/11/2006	9/12/2006	9/13/2006	9/25/2006	9/26/2006	9/27/2006	10/9/2006	10/10/2006	10/11/2006	10/23/2006	10/24/2006	10/25/2006
Cumulative Precipitation (inches)[1]	1.49	-	-	1.58	-	-	1.80	-	-	0.92	0.00	0.00	1.21	-	-	0.68	-	-	1.30	-	-
Well No.	Water Elevation (ft. MSL)																				
1			1585.28			1585.51			1585.99			1585.38			1585.97			1586.05			1586.34
1M			1588.18			1585.51			1587.28			1587.96			1587.41			1587.34			1587.12
2		1599.99			1600.24			1600.49			1600.24			1600.35				1600.35		1600.47	
3			1596.56			1596.50			1596.65			1596.52			1596.58		1596.92				1597.06
4			1615.18			1615.16			1615.28			1615.12			1615.26		1615.24				1615.41
4M																					
4A			1597.72			1597.69			1597.86			1597.74			1597.82		1597.84				1597.99
5			1615.44			1615.42			1615.55			1615.38			1615.49		1615.47				1615.63
6	1597.43			1597.03			1597.97			1597.72			1597.81			1597.78			1597.99		
7			1557.79		1557.77			1557.85			1557.43			1557.89			1557.83			1558.06	
7M			1557.89																		
8	1563.56				1563.52		1563.49				1563.37			1563.45				1563.56		1563.70	
9	1565.41				1565.37			1565.56			1565.41			1565.45				1565.56		1565.68	
10		1598.02		1598.17			1598.23			1598.11			1598.13			1598.15			1598.27		
11		1596.79		1596.92			1597.00			1596.94			1596.96			1596.94			1597.02		
12		1591.64			1591.80			1592.14			1591.93			1591.97				1591.68		1591.95	
12M																					
13																1579.35			1579.48		
14	1573.90			1573.98			1574.04			1573.98			1574.06			1574.04			1574.19		
15	1571.77			1572.06			1572.14			1572.00			1572.02			1572.06			1572.21		
16	1585.96				1585.90			1586.07			1585.94			1586.03				1586.11		1586.23	
17			1598.87			1598.83			1598.95			1598.81			1598.87		1598.85				1599.00
18		1595.13		1595.26			1595.32			1595.18			1595.24			1595.20			1595.34		
19			1585.91			1585.95			1586.11			1585.45			1585.53		1585.49				1585.74
722057																					

Table 4
Precipitation Summary Compared to WETS[1] Data
1999-2006
PolyMet Mining
Babbitt, Minnesota

	30% chance			Babbitt							
	Average	more than	less than	1999	2000	2001	2002	2003	2004	2005	2006
	Inches										
January	0.88	0.52	1.07	0.73	0.55	**1.21**	*0.12*	*0.19*	**1.23**	**2.15**	*0.42*
February	0.7	0.36	0.86	0.6	0.71	**1.77**	*0.26*	0.44	*0.23*	0.5	**0.88**
March	1.1	0.63	1.34	1.01	1.11	*0.22*	0.96	0.82	0.64	*0.95*	**1.69**
April	1.96	1.27	2.35	1.7	*0.9*	**5.07**	*0.47*	1.56	1.63	1.91	1.82
May	3.01	1.89	3.63	**5.13**	**3.65**	**6.69**	*1.72*	2.16	**4.53**	**9.01**	3.35
June	4.29	3.26	5	3.96	**5.89**	3.79	4.28	3.36	*1.45*	**5.78**	*1.71*
July	3.37	2.44	3.96	**13.51**	**4.08**	**4.91**	**5.13**	**5.51**	3.23	*1.42*	**4.92**
August	3.94	2.73	4.7	**4.91**	**5.14**	**9.59**	**4.9**	*1.9*	3.01	*1.77*	*2.10*
September	3.65	2.44	4.36	**5.33**	*2.23*	*1.41*	3.74	**5.42**	4.04	2.79	*2.13*
October	2.88	1.77	3.48	*1.48*	2.34	**4.07**	2.16	*1.5*	3.08	2.78	1.98
November	1.75	1	2.13	*0.09*	1.33	2.02	*0.29*	1.49	*0.34*	**3.44**	
December	1.07	0.74	1.27	*0.19*	0.81	*0.67*	*0.5*	0.88	**1.96**	0.90	
Annual	28.6	*25.96*	**30.86**	**38.64**	28.78	**41.42**	*24.53*	*25.23*	*25.37*	**33.40**	
Water Year					26.06	**39.14**	28.34	*24.31*	*23.86*	**31.66**	26.14

[1] The only normal period available for Babbitt is 1961-1985, which is the basis of the data above.
Bold = above the normal range
Italics = below the normal range

P:\23\69\862\WO 008 Corps Wetlands Permit\WetlandHydroStudy\PolyMetRS44_2006\StLouis_WETS_VA_90_04.xlsBabbittWETS



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Legend

- Detailed Watersheds
- Wetlands
- Streams
- Mine/Stockpile Project Area

Wetland Monitoring Wells - As-Built

Future Status

- Ground Water Monitoring Well
- Potentially Impacted
- Secure Long-term
- 16 Well ID

1587.08 Ground Elevation
1586.2 Average 2005 Water Elevation
1586.2 Average 2006 Water Elevation

0 750 1,500 Feet

Figure 1

WETLAND MONITORING
GROUND AND WATER
LEVEL ELEVATIONS
PolyMet Mining
Hoyt Lakes, Minnesota

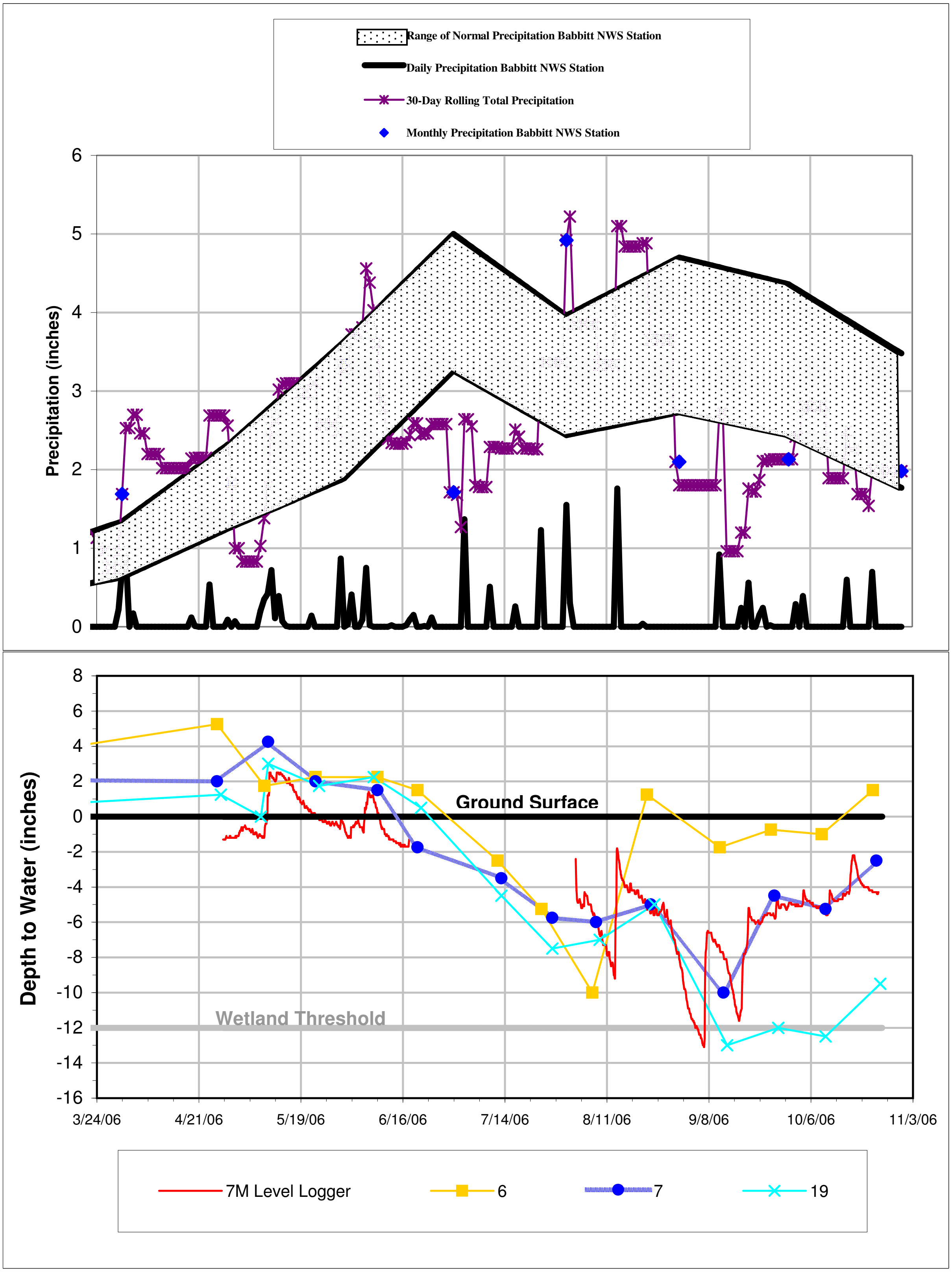


Figure 2
2006 HYDROLOGY MONITORING DATA
Southwest Mine Site
PolyMet Mining
Hoyt Lakes, Minnesota

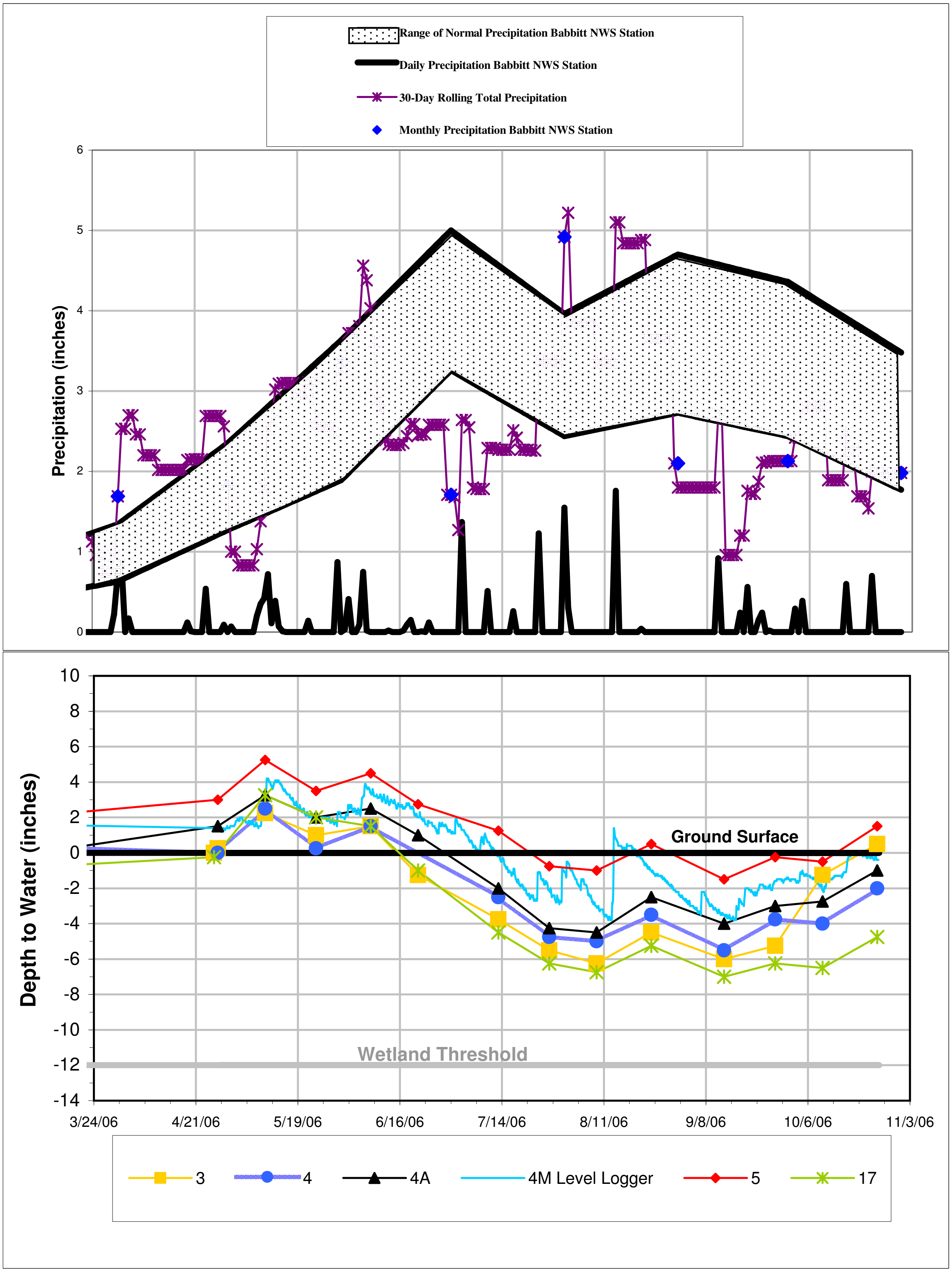


Figure 3
2006 HYDROLOGY MONITORING DATA
Northwest Mine Site
PolyMet Mining
Hoyt Lakes, Minnesota

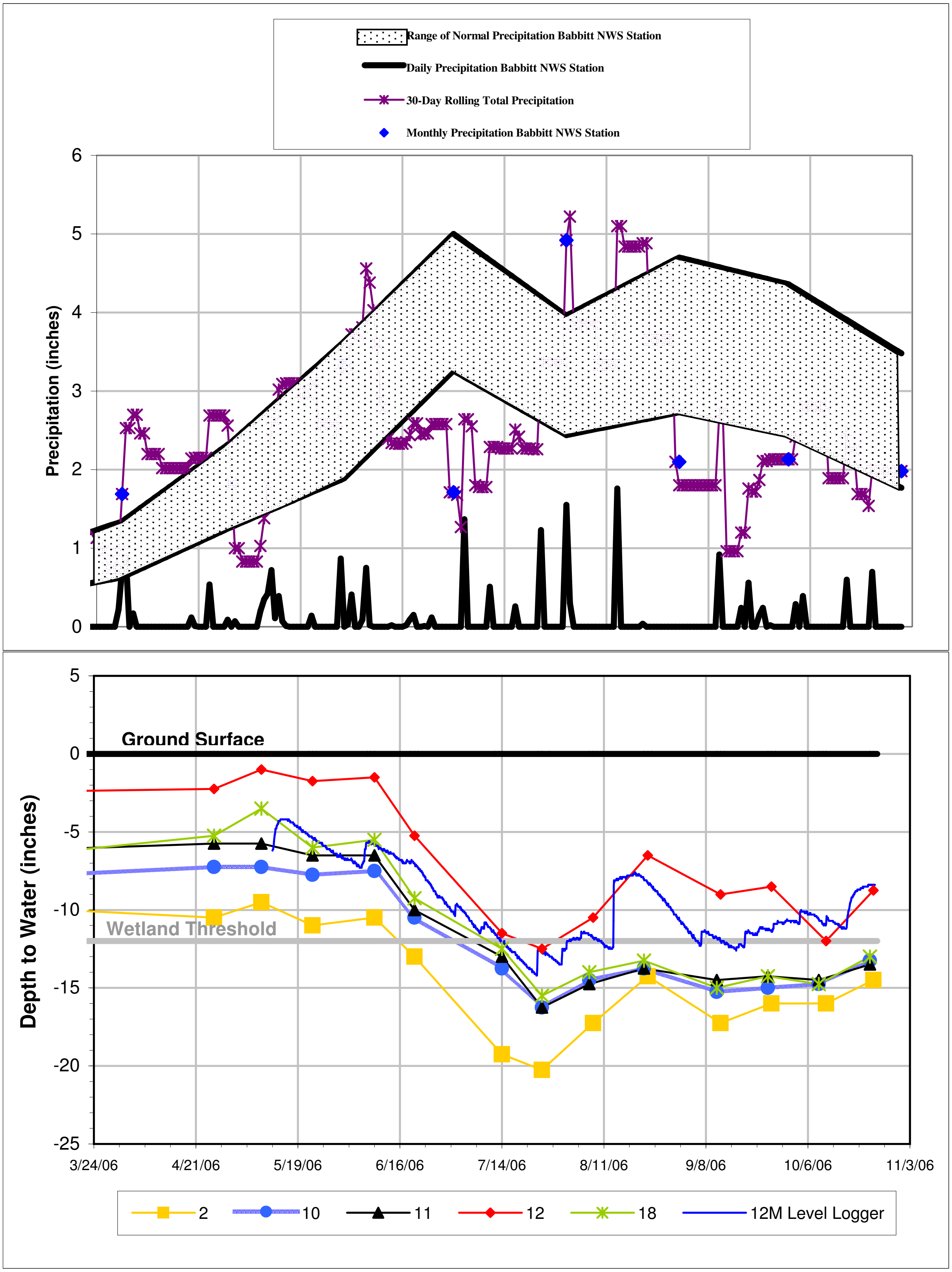
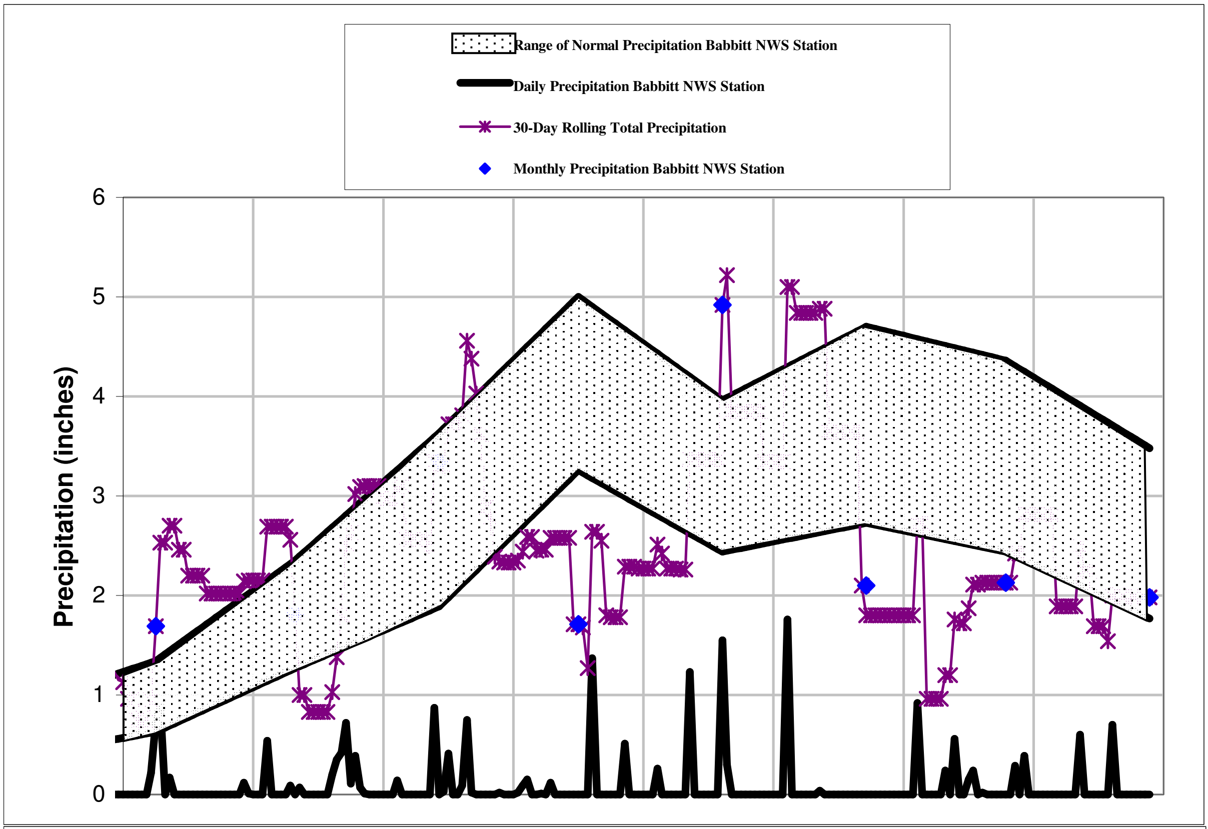


Figure 4
2006 HYDROLOGY MONITORING DATA
North-Central Mine Site
PolyMet Mining
Hoyt Lakes, Minnesota



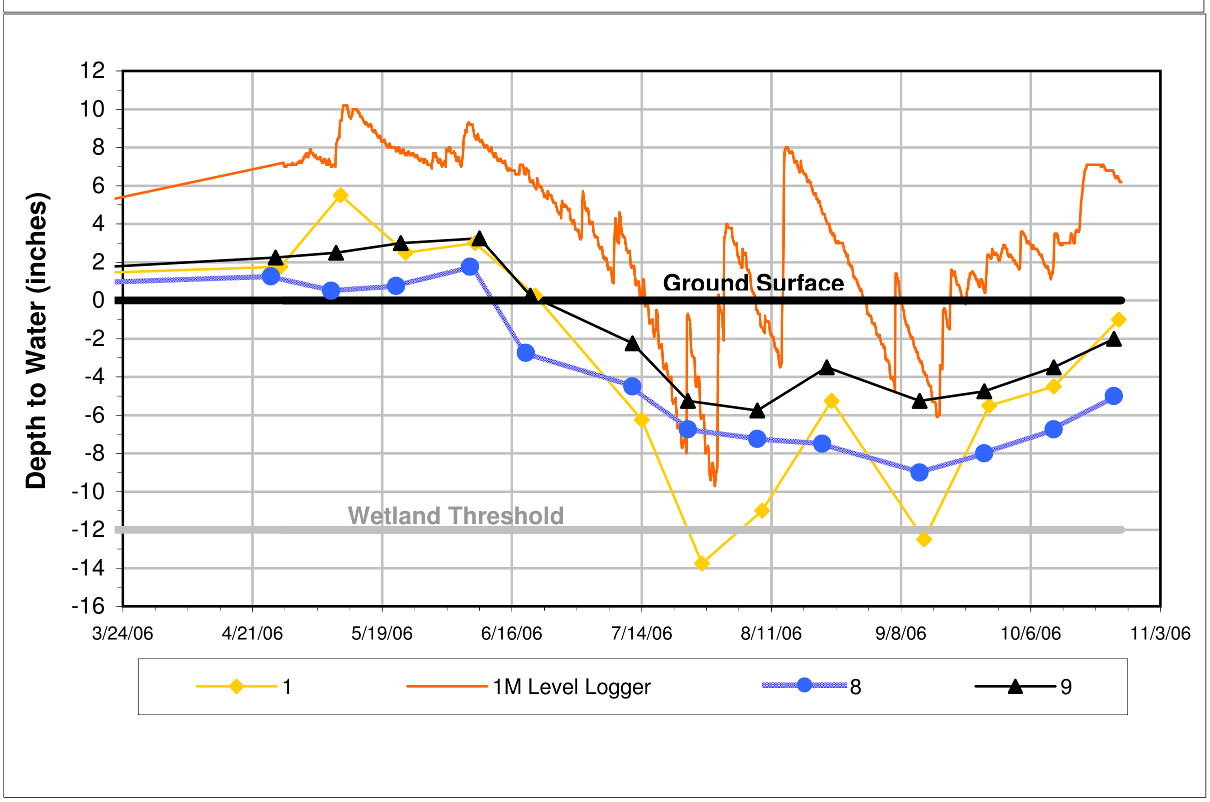


Figure 5
2006 HYDROLOGY MONITORING DATA
South-Central Mine Site
PolyMet Mining
Hoyt Lakes, Minnesota

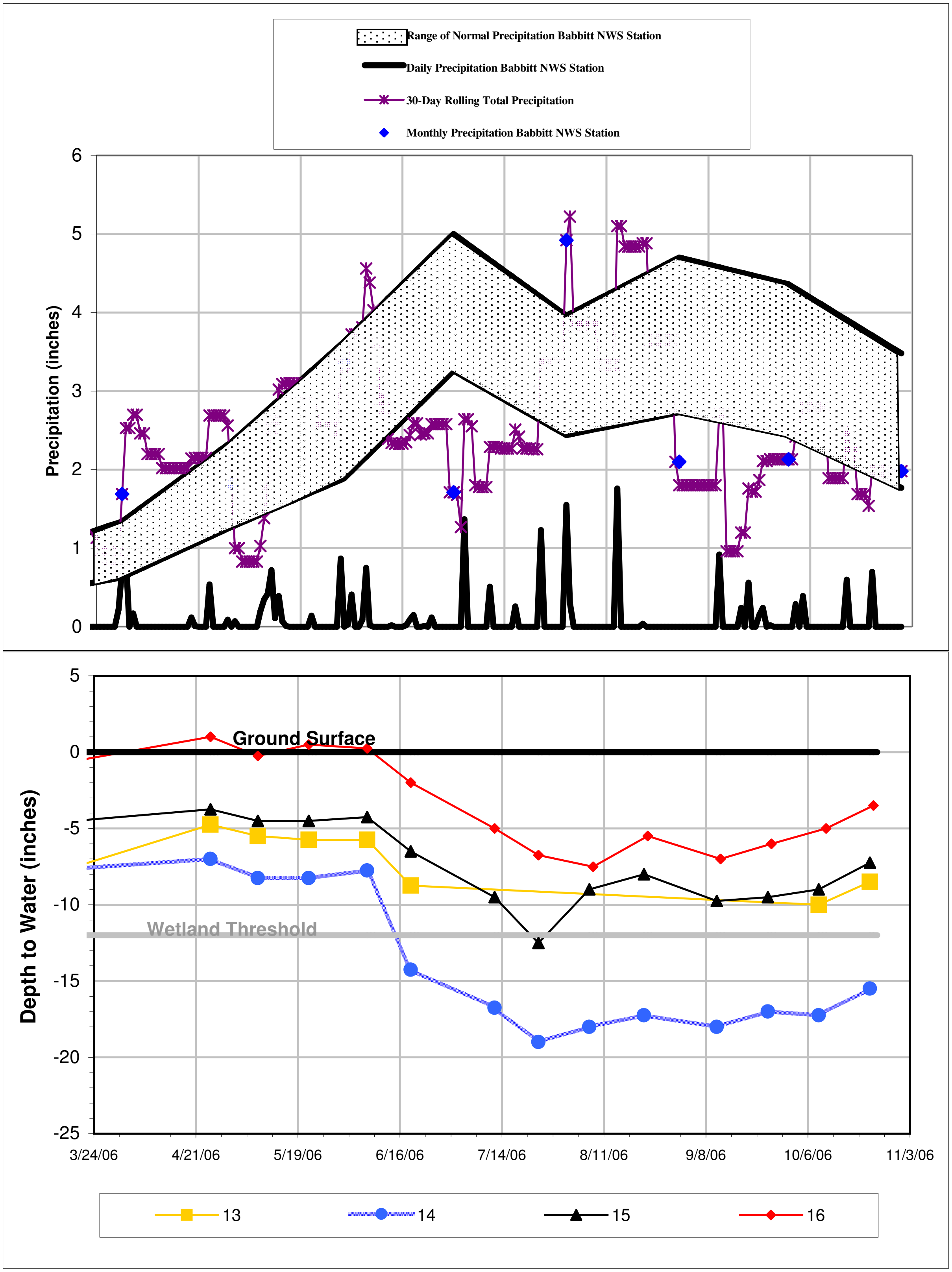


Figure 6
2006 HYDROLOGY MONITORING DATA
Northeast Mine Site
PolyMet Mining
Hoyt Lakes, Minnesota

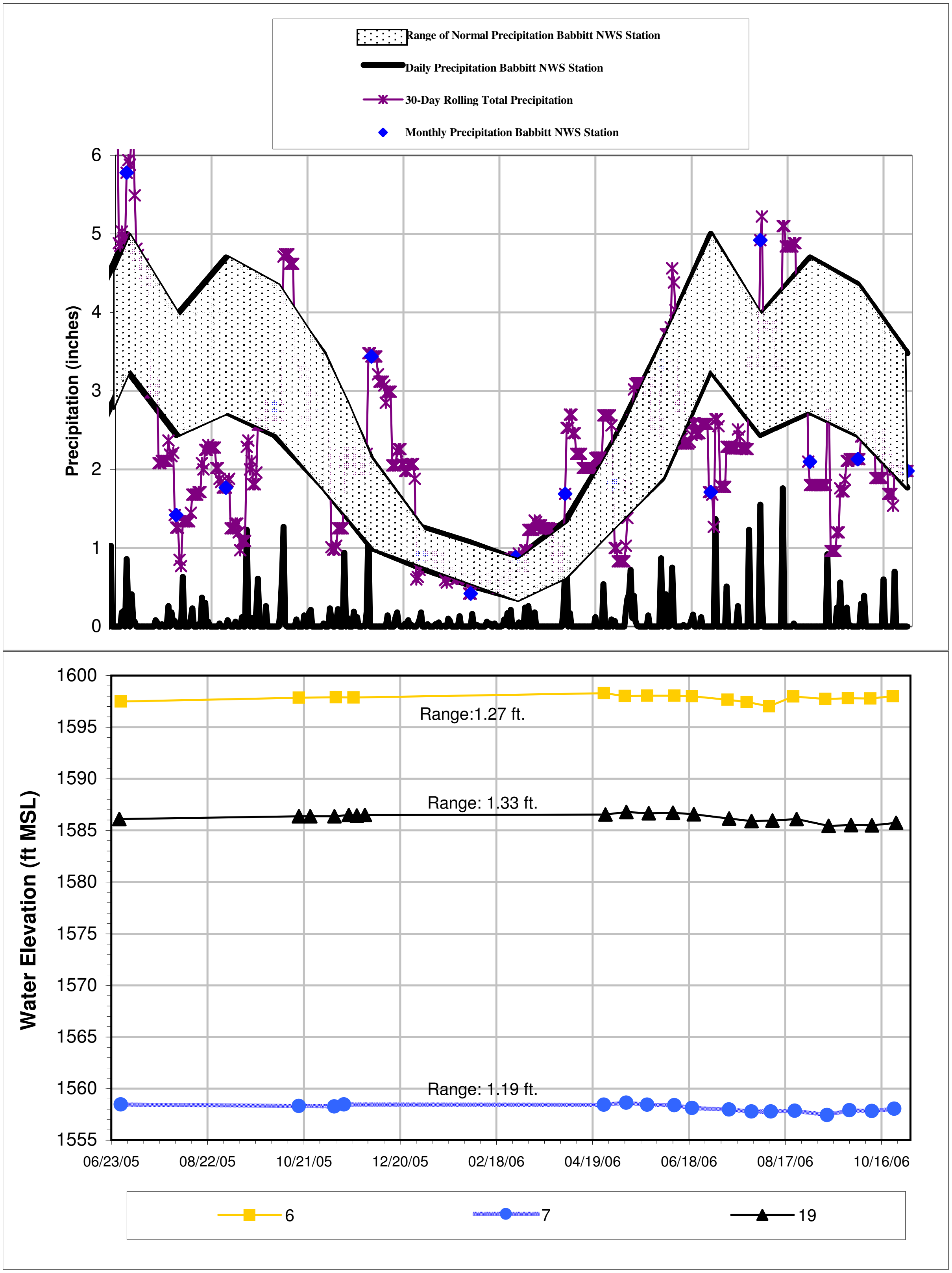


Figure 7
2005-2006 HYDROLOGY MONITORING DATA
Southwest Mine Site
PolyMet Mining
Hoyt Lakes, Minnesota

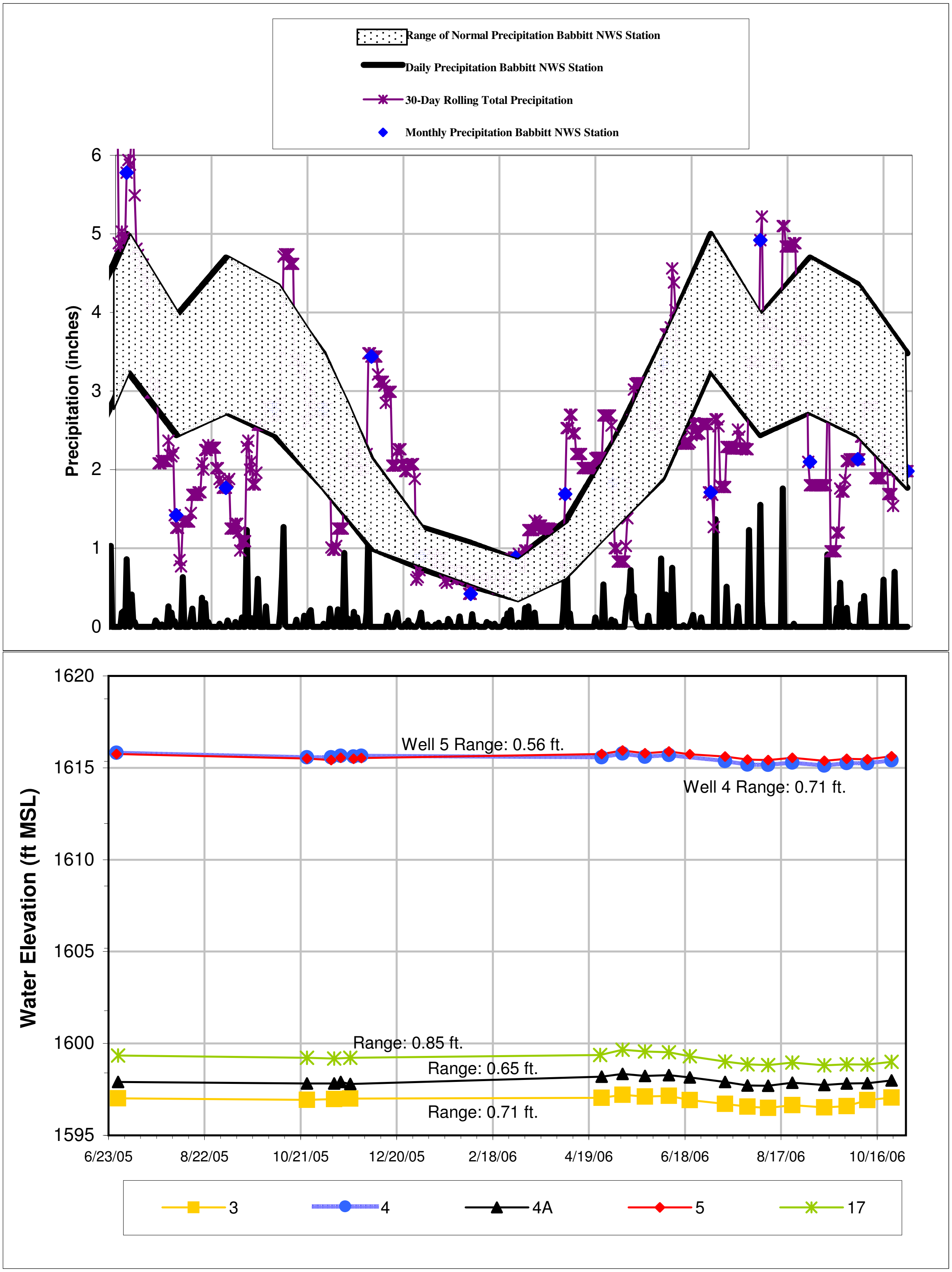


Figure 8
2005-2006 HYDROLOGY MONITORING DATA
Northwest Mine Site
PolyMet Mining
Hoyt Lakes, Minnesota

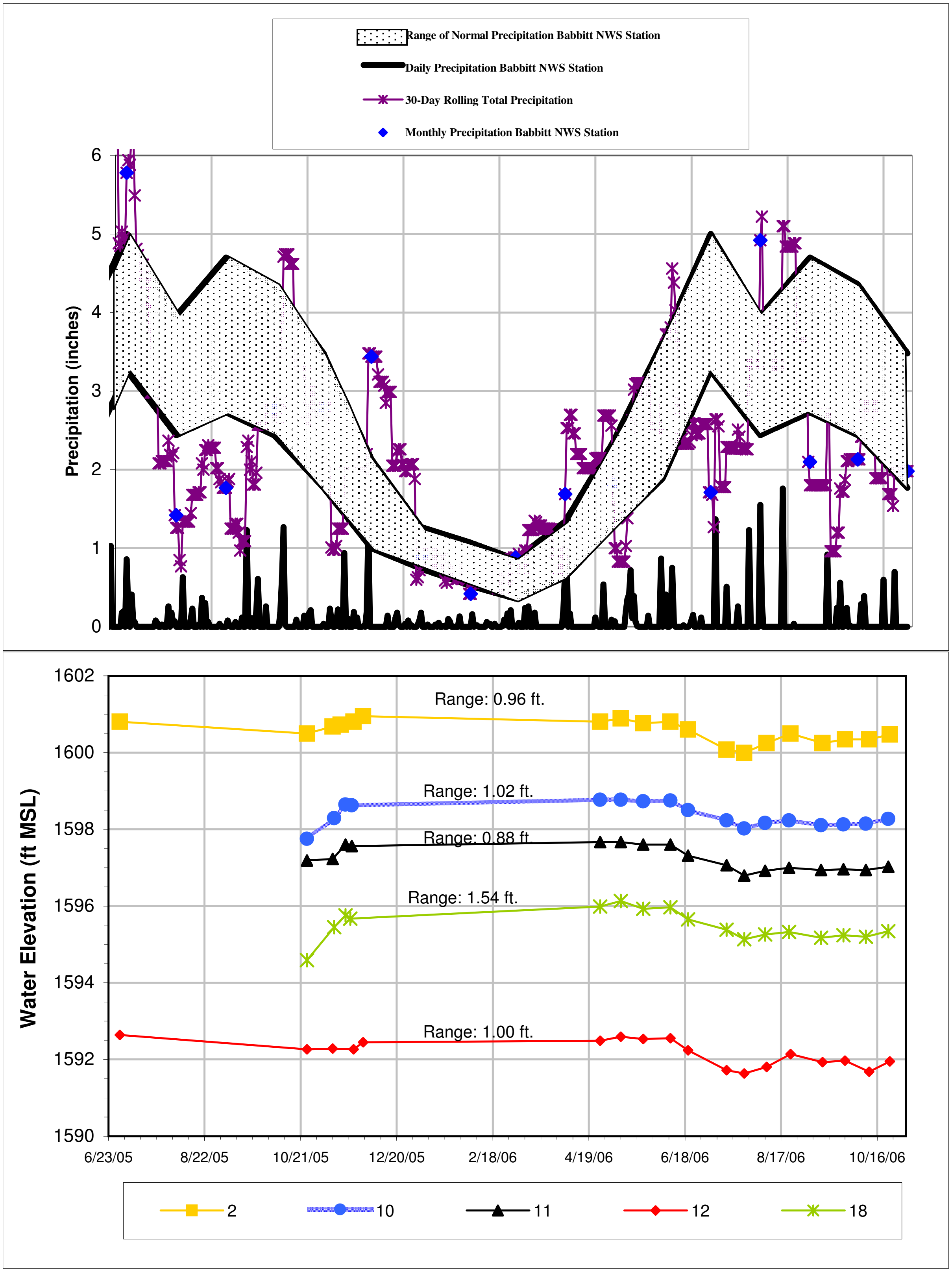


Figure 9
2005-2006 HYDROLOGY MONITORING DATA
North-Central Mine Site
PolyMet Mining
Hoyt Lakes, Minnesota

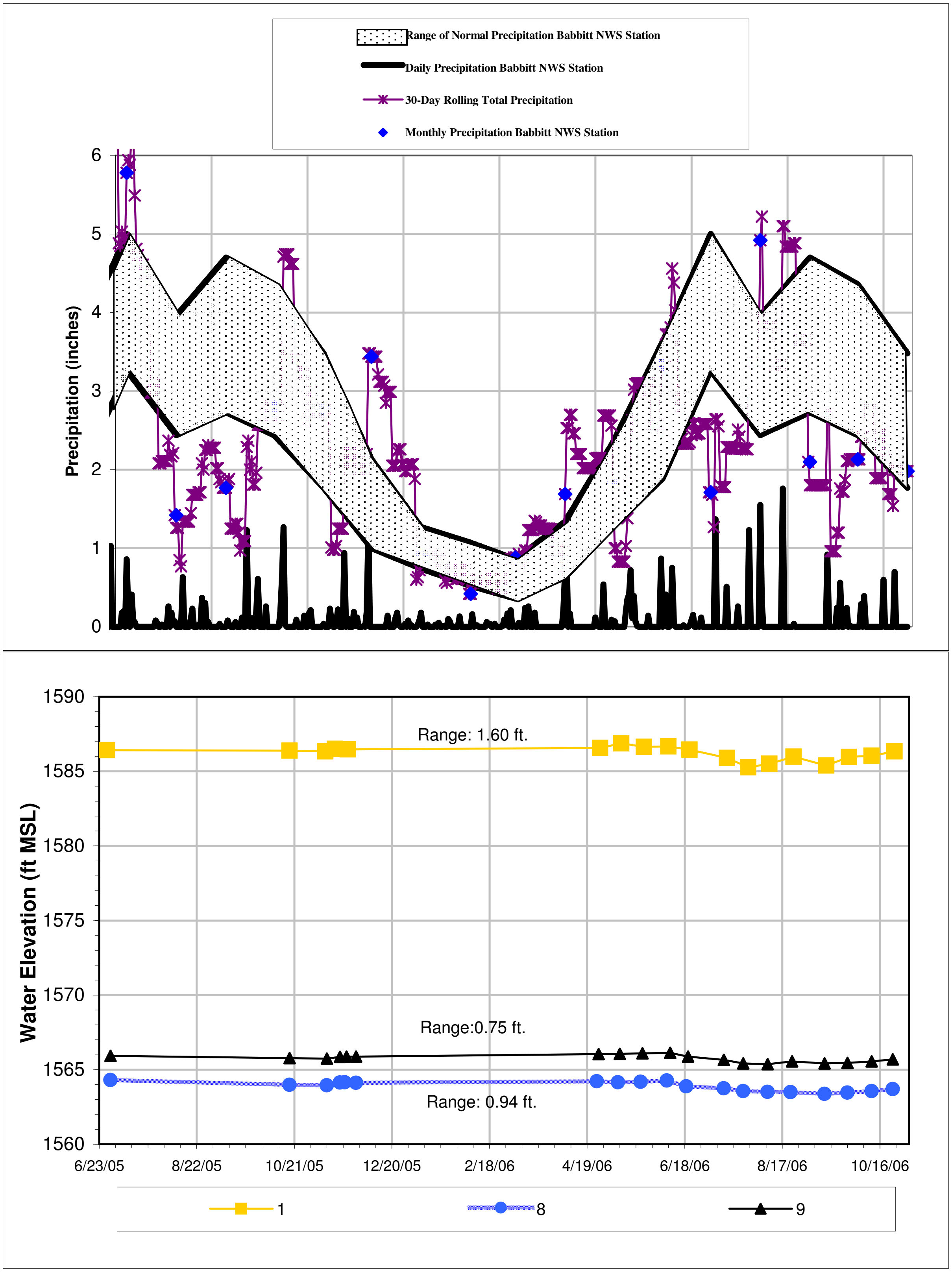


Figure 10
2005-2006 HYDROLOGY MONITORING DATA
South-Central Mine Site
PolyMet Mining
Hoyt Lakes, Minnesota

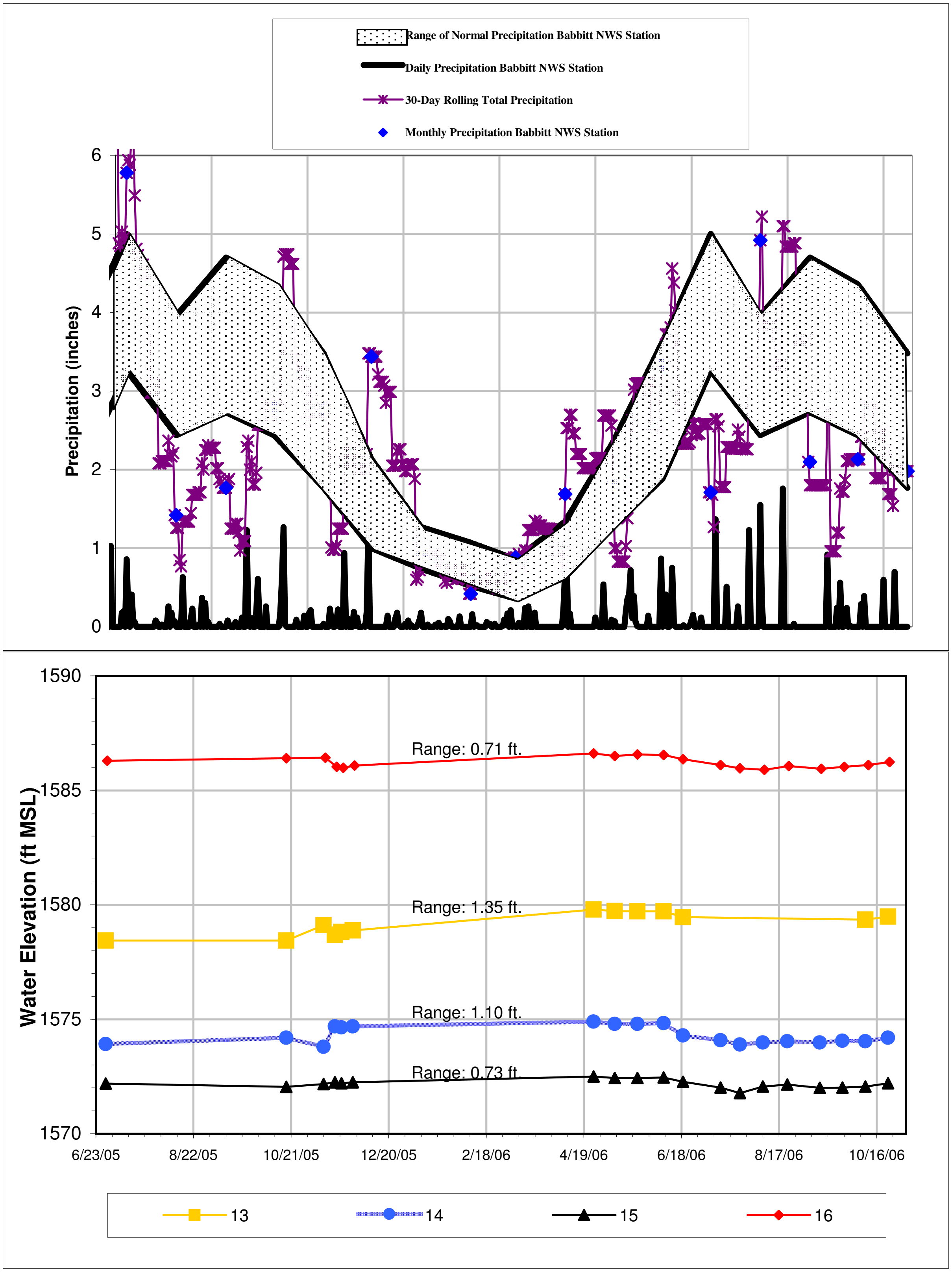


Figure 11
2005-2006 HYDROLOGY MONITORING DATA
Northeast Mine Site
PolyMet Mining
Hoyt Lakes, Minnesota

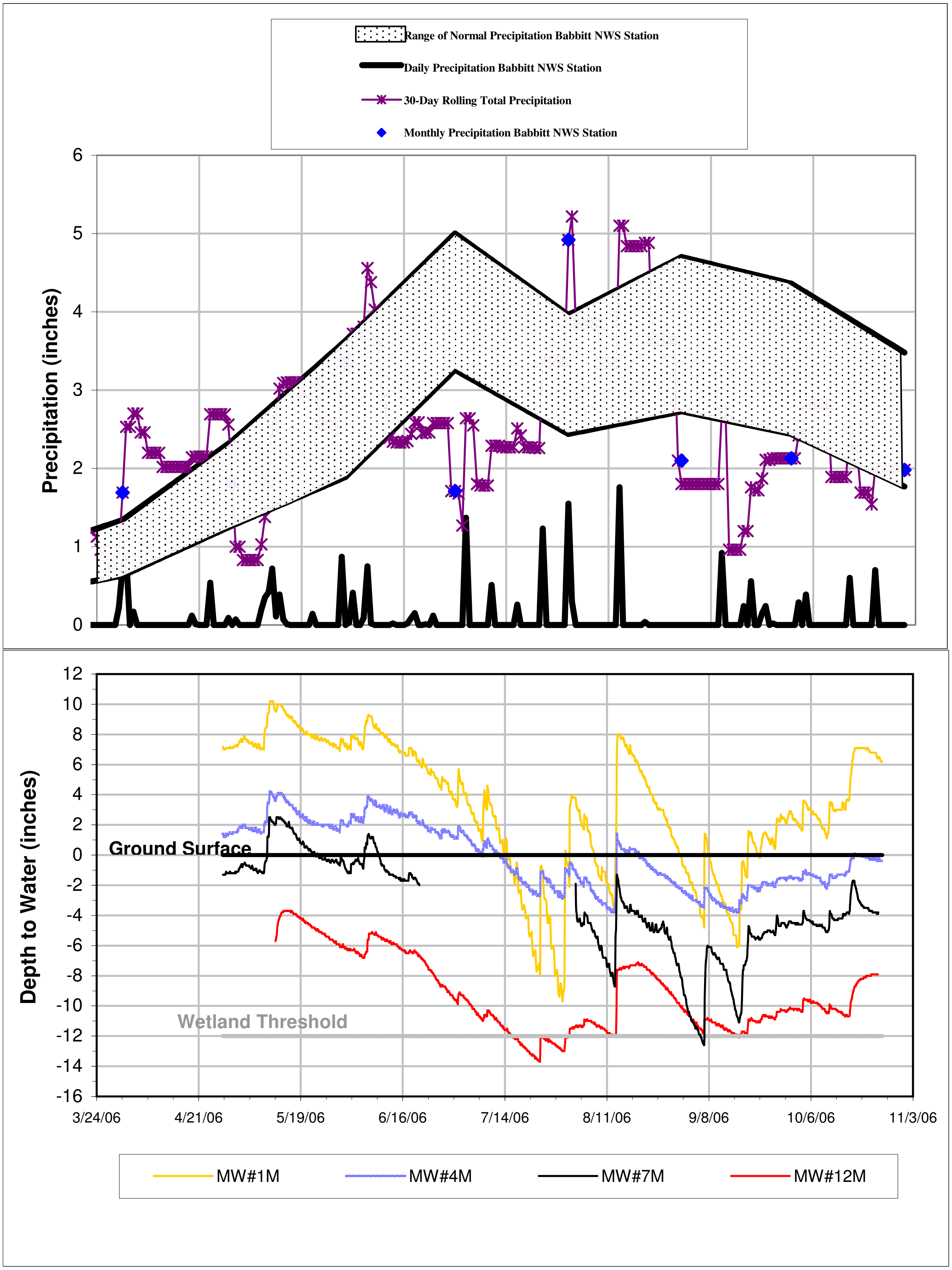


Figure 12
2006 RECORDING WELL MONITORING DATA
PolyMet Mining
Hoyt Lakes, Minnesota