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Technical Memorandum

To: Mike Mueller, MDNR
From: Tina Pint and Ellen Considine
Subject: Sunrise River Energy Station Test Well #1 – Geology and Well Information
Date: June 26, 2009
Project: 23131001.00 002 004
c: Jeanette Leete, MDNR; Jim Sehl, MDNR; Blake Wheatley, LS Power; Sharon Shelby, LS Power; Teri Perry, Barr

This memorandum is intended to provide background geology and well information for the area surrounding the Sunrise River Energy Station Site (the Site) located in Chicago County, Minnesota (Figure 1). LS Power Development, LLC, through Sunrise River Energy, LLC, its affiliate, is proposing to build a 780 MW gas-fired electrical generating facility (the Facility) at the Site. Discharge from the Chisago Lakes Waste Water Treatment Plant (WWTP) will be used as the primary water supply for the Facility. However, an additional water source is needed (1) to make up the difference between the water demand for the Facility and the discharge from the WWTP and (2) to provide emergency supply in case water from the WWTP is unavailable or unusable. LS Power's preferred source for additional water is the Mt. Simon Formation. A detailed discussion of the water balance for the Facility is beyond the scope of this document; however, it is anticipated that an average monthly withdrawal of 2 million gallons per day (MGD) and maximum daily withdrawal of 5 million gallons from the Mt. Simon Aquifer will be needed.

LS Power does not currently have any production wells for the Facility. Their intent is to install a series of test wells that could be converted to production wells. A pumping test will be conducted on each test well individually. The test wells will be constructed in a manner that will allow them to be converted to production wells. It is understood that an additional aquifer test with all possible production wells pumping simultaneously will be required by the Minnesota Department of Natural Resources (MDNR) as part of the appropriation permit application. The first test well (referred to here as Test Well #1) will be installed in the northwest corner of the Site (Figure 1).

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This memorandum presents the geologic setting for the Site and information on wells located within 1.5-miles of Test Well #1. This information is being provided to facilitate discussion between the MDNR, LS Power and Barr Engineering regarding the first aquifer test using Test Well #1. It is understood that additional information will be needed prior to the aquifer test, as outlined in the June 12, 2009 letter to Blake Wheatley from Mike Mueller.

1. Geologic Setting

Current understanding of the Site's geology is based on the following sources:

- Boring logs from the Minnesota County Well Index (CWI, maintained by the Minnesota Department of Health, 2009)
- Bedrock Geology of Chisago County (provided in draft form by the Minnesota Geological Survey (MGS), 2009)
- Quaternary Geologic Map of Chisago County, Minnesota (MGS, 1993)
- Aggregate Resource Potential of Chisago County, Minnesota (MGS, 2001)
- Surficial Geology of the Stillwater 30 x 50 Minute Quadrangle, Minnesota (MGS, 1999)
- Bedrock Geology and Structure of the Seven-County Metropolitan Area, Minnesota (MGS, 2000)
- Soil survey data (available online from the U.S. Department of Agriculture, Natural Resources Conservation Service)

The geology of the Site consists of approximately 100 to 400 feet of unconsolidated glacial deposits overlying an erosional Paleozoic bedrock surface.

1.1 Bedrock Deposits

The Site appears to directly overlie a bedrock valley which trends northeast-southwest (based on draft MGS data, 2009) (Figure 2 and Figure 3). Bedrock in the vicinity of the Site dips southward. The youngest bedrock units present in the vicinity of the Site are located approximately one mile south of the Site. These are remnants of the Tunnel City Group and Wonewoc Formation (formerly known as the Franconia and Iron-ton-Galesville Formations, respectively), which overlie the Eau Claire Formation. The Eau Claire Formation is present to the south and east of the Site and is approximately 100 feet thick. It is thought that the bedrock valley cuts through the Eau Claire Formation and into the Mt. Simon Formation but does not incise through the Mt. Simon Formation to the underlying volcanics (based on draft MGS data). The thickness of the Mt. Simon Formation at the deepest part of the bedrock valley is thought to be

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on the order of 50 to 100 feet. Where present to its full thickness 5 miles southeast of the Site, the Mt. Simon Formation is approximately 250 feet thick (CWI). In the opposite direction, about 5 miles northwest of the Site in North Branch, the Mt. Simon Formation is approximately 50 feet thick (CWI).

1.2 Unconsolidated Deposits

Surficial soil at the Site is generally loamy fine sand (USDA, 2009), which is underlain by approximately 20 to 30 feet of sand. The sand, which comprises the New Brighton Formation, is lacustrine in origin (MGS, 1999). It is underlain by approximately 50 to 100 feet of sandy clay, which is likely also lacustrine (MGS, 1993). Approximately 75 to 100 feet below ground surface and below the sandy clay, is a gravelly clay which may be diamicton till. The gravelly clay ranges from approximately 50 to 100 feet thick and may not be laterally continuous below the site, although the sandy clay does appear to underlie the entire Site (see Figures 4 and 5). Both the sandy clay and gravelly clay contain sand lenses. Directly below the Site and to the north and west of the Site, the gravelly clay is underlain by a sand and gravel deposit at least 50 to 100 feet thick. Many domestic wells in the Site's vicinity are screened in the sand and gravel deposit (Figure 3). South of the Site, the sand and gravel deposit appears to terminate and the gravelly clay appears continuous to bedrock. East of the Site, the sand and gravel deposit grades into a lacustrine deposit and/or terminates against a reworked bedrock deposit. There are no deep wells placed in the bedrock valley (described above), so the geology of unconsolidated sediments in the valley is unknown (see Figure 7).

2. Area Wells

Wells located within a 1.5-mile radius of the proposed Test Well #1 were identified using the Minnesota Department of Health's County Well Index (CWI) (Figure 6). Based on this information, 122 wells are located within the 1.5-mile radius area:

- 105 wells are completed within the unconsolidated deposits,
- 9 wells are completed in the Tunnel City or Wonewoc Formations,
- 3 are completed in the Eau Claire Formation,
- 1 is completed in the Eau Claire and Mt. Simon Formations,
- 2 are completed in the Mt. Simon Formation, and
- 2 have no geology or aquifer information.

Table 1 summarizes well information from the CWI for these wells. A door-to-door survey has not been conducted to identify other possible wells in the area.

LS Power - Sunrise River Energy Station

Data Source	Unique Well				Address	T	R	S	Subsections	Elevation	Well Depth ft.	Well Bottom	Diameter in inches	Casing Type	Static Water level	Drop Pipe Length	Pump Capacity (GPM)	Pump Type	Contractor	Aquifer	Comments
	Map ID	Number.	Well Owner Name	Phone #																	
MNDH-CWI	73	641095	BUSSEN		34740 Kale LA North Branch MN	34	21W	12	ADBBAD	889	225	664	4	Plastic	0			Mccullough & Sons	QBAA		
MNDH-CWI	74	415238	HELLIG, BRUCE		11200 347th Street Lindstrom MN 55045	34	20W	7	ADBBAD	912	129	783	4	Steel	53	84	10	submersible	Johnson G. Well Co.	QBAA	
MNDH-CWI	75	512535	PRASKA		34764 Kable Ave Stacy MN 55079	34	21W	12	BACDCC	892	104	788	4	Steel	20	10	60		Anderson A. well	QBAA	
MNDH-CWI	76	575164	O'DONNELL, STEVE & JODIE		11100 Lang Av North Branch MN 55056	34	20W	7	ABCCDB	860	65	795	4	Plastic	0	20	10	submersible	Mccullough & Sons	QBAA	
MNDH-CWI	77	634708	PRICE		8954 347th St North Branch MN 55056	34	21W	11	ABDCAB	896	110	786	4	Plastic	35	80		submersible	Lauren Mccullough Well Drilling	QBAA	
MNDH-CWI	78	615537	GEISE		9020 347th St Stacy MN	34	21W	11	ABDACA	895	85	810	4	Plastic	20	55	10	submersible	Mccullough & Sons	QBAA	
MNDH-CWI	79	412872	RENSINK, DOUG		34880 Linden Av MN	34	20W	7	AACBBB	870	105	765	4	Steel	10	42	10	submersible	Johnson G. Well Co.	QBAA	
MNDH-CWI	80	489001			9179 Lent Tr Stacy MN	34	21W	12	BBDBDB	892	113	779	4	Steel	26	60	12	submersible	Ruppert & Son	QBAA	
MNDH-CWI	81	615546	ANDERSON		9080 347th St Stacy MN	34	21W	11	AACBAD	895	96	799	4	Plastic	20	55	10	submersible	Mccullough & Sons	QBAA	
MNDH-CWI	82	535225	TURNER, RICK		9179 Lent Tr Stacy MN	34	21W	12	BBDBDB	892	122	770	4	Plastic	20			Zuercher Well Co.	QBAA		
MNDH-CWI	83	716780	ALLISON		9216 347th Street Stacy MN 55079	34	21W	11	AADBBB	895	144	751	0	Plastic	30	60	12	submersible	Barott B. Well Co.	QBAA	
MNDH-CWI	84	565316	BYERS		8814 347th St Stacy MN	34	21W	11	ABCBCA	899	110	789	4	Plastic	36	60		submersible	Sampson Well Co.	QBAA	
MNDH-CWI	85	636051	GREY, WAYNE		34761 Lang Av Stacy MN	34	20W	7	BADAAD	868	198	670	4	Plastic	7			Johnson G. Well Co.	QBAA		
MNDH-CWI	86	631239	LINDBECK, BILL			34	21W	11	AACABA	895	152	743	4		30					QBAA	
MNDH-CWI	87	694947	ANDERSON, ROGER		17342 65 UH Albert Lea MN 56007	34	20W	7	AABDBD	867	81	786	4	Steel	10	40	10	submersible	Morrison Well Co.	QBAA	
MNDH-CWI	88	471072	MUELLNER		9187 Lent Tr MN	34	21W	12	BBBCDA	892	135	757	4	Plastic	0	86	10	submersible	Schroepfer Well Co.	QBAA	
MNDH-CWI	89	448319	ORWOLL, KEN		34914 Linden AV MN	34	20W	7	AACBCB	870	95	775	4	Steel	12	40		submersible	Lauren Mccullough Well Drilling	QBAA	
MNDH-CWI	90	512093	GOZZI, GREG		9183 Lent Tr Stacy MN	34	21W	12	BBADBC	885	112	773	4	Plastic	23	60	25	submersible	Husnik Well Co.	QBAA	
MNDH-CWI	91	473019	HOUSE OF PRAYER		34888 Kable Ave Stacy MN	34	21W	12	BAACBD	893	198	695	4	Steel	25	63	10	submersible	Johnson G. Well Co.	QBAA	
MNDH-CWI	92	638072	REICHERT		9280 Lent Tr North Branch MN	34	21W	11	AAADBA	892	104	788	4	Steel	15			Lauren Mccullough Well Drilling	QBAA		
MNDH-CWI	93	435035	STROUT, WILLIAM		34946 Linden Av MN	34	20W	7	ABAADC	865	95	770	4	Steel	7	32	10	submersible	Johnson G. Well Co.	QBAA	
MNDH-CWI	94	519048	DIXON, RICHARD		35304 Lincoln Rd Stacy MN	34	21W	12	BABBDD	886	79	807	4	Steel	16	40	10	submersible	Martin Lake Garage	QBAA	
MNDH-CWI	95	512077	PALMBERG, CLIFF		34970 Kable Ave Stacy MN	34	21W	12	BAABDD	892	203	689	4	Plastic	25	60	20	submersible	Husnik Well Co.	QBAA	
MNDH-CWI	96	513523	HEBRINK		9209 Lent Tr Stacy MN	34	21W	12	BBBCC	892	113	779	4	Plastic	25	60	12	submersible	Husnik Well Co.	QBAA	
MNDH-CWI	97	162969	NORTH BRANCH FUR FARM			34	21W	1	DDADCD	881	200	681	6	Steel	24.4	100	60	submersible	Mantyla Well Co.	QBAA	
MNDH-CWI	98	713098	HERBST, LUKE			34	21W	2	CADCCB	899	95	804	0		37					QBAA	
MNDH-CWI	99	512420	NELSON, JOHN		35367 Kost Tr MN	34	20W	6	CACBCD	881	147	734	4	Plastic	30	100		submersible	Lauren Mccullough Well Drilling	QBAA	
MNDH-CWI	100	612914	OLSON, JIM		35690 Lincoln Rd North Branch MN	34	21W	2	DBBBAC	898	14	884	1.3	Steel	0			Handpump	Owner	QUUU	
MNDH-CWI	101	562399	SHANAHAN, BRENT		11312 Loftman Tr North Branch MN 55056	34	20W	5	BCCCCC	911	120	791	4	Plastic	50			submersible	Lauren Mccullough Well Drilling	QBAA	
MNDH-CWI	102	528700	BLOOM		11332 Loftman Tr North Branch MN 55056	34	20W	5	BCCBCD	909	460	449	4	Steel	46	84	10	submersible	Johnson G. Well Co.	CBMS	
MNDH-CWI	103	702270	JOHNSON		35824 Lincoln Rd North Branch MN 55056	34	21W	2	ADABBC	896	137	759	4	Plastic	33	60	10	submersible	Sampson Well Co.	QBAA	
MNDH-CWI	104	744019				34	21W	1	BCBABB	889	0	889	0		0						
MNDH-CWI	105	641840	KOECHER, MARK		8907 360th St North Branch MN	34	21W	2	ABCDDB	895	147	748	4	Plastic	10	60	10	submersible		QBAA	
MNDH-CWI	106	681834	GAIIOVIK, JIM		35880 Lincoln Rd North Branch MN 55056	34	21W	2	AADCBC	896	160	736	4	Plastic	27	60		submersible	Barott B. Well Co.	QBAA	
MNDH-CWI	107	761193				34	21W	1	BBDACD	889	0	889	0		0						
MNDH-CWI	108	625128	KOECHER, KEITH		9035 360th St North Branch MN 55056	34	21W	2	ABDAAA	896	165	731	4	Plastic	30	50		submersible	Lauren Mccullough Well Drilling	QBAA	
MNDH-CWI	109	709812	AKER, BRAD		35803 Jensen Rd North Branch MN	34	21W	1	BBADCD	895	192	703	4	Plastic	37	80	17		Sampson Bros. Well Co. Inc.	QBAA	
MNDH-CWI	110	662770	LARSON, DON		8605 360th Street North Branch MN 55056	34	21W	2	BABACC	898	150	748	4	Plastic	32	90	20	submersible	Schroepfer Well Drilling Inc.	QBAA	
MNDH-CWI	111	733477			35919 Jensen Rd North Branch MN 55056	34	21W	1	BBABAC	894	200	694	4	Plastic	40	80		submersible	Lauren Mccullough Well Drilling	QBAA	
MNDH-CWI	112	698275	LARSON, DON		8605 360th Street North Branch MN 55056	34	21W	2	BABABC	898	160	738	4	Plastic	30	80	20	submersible	Schroepfer Well Drilling Inc.	QBAA	
MNDH-CWI	113	465957	LESSMAN, JOE		8914 360 th ST North Branch MN 55056	35	21W	35	DCDBCC	897	186	711	4	Plastic	20			Lauren Mccullough Well Drilling	QBAA		
MNDH-CWI	114	747202	PICKARD, CODY		9084 360th Street North Branch MN 55056	35	21W	35	DCCBAA	900	180	720	4	Plastic	34	60	15	submersible	Mork Well Co. Inc.	QBAA	
MNDH-CWI	115	609617	BENSON, DAVE & MICHELLE		36273 Lincoln Tr North Branch MN 55056	35	21W	35	DADDAD	899	143	756	4	Plastic	35	60	12	submersible	Husnik Well Co.	QBAA	
MNDH-CWI	116	716418	JBS CARPENTRY		36330 Lincoln Tr MN	35	21W	35	DACDBA	901	175	726	4	Plastic	40		10	submersible	STM Industries , LLC	QBAA	
MNDH-CWI	117	674711	WHITE, LAWRENCE		36329 Lincoln Trail North Branch MN	35	21W	36	CBCBDB	899	140	759	4	Plastic	34	66	12	submersible	Schroepfer Well Drilling Inc.	QBAA	
MNDH-CWI	118	620447	PERRAULT, STEVE			35	21W	36	CADBBB	896	94	802	4	Steel	34	69	10	submersible	Rosga Well Co.	QBAA	
MNDH-CWI	119	473681	PERRAULT, ROGER		36338 July AV North Branch MN 55056	35	21W	36	CACBAB	894	115	779	4	Steel	33	67	10	submersible	Rosga Well Co.	QBAA	
MNDH-CWI	120	416399	PERRAULT, ADRIAN		620 4 RD MN 55056	35	21W	36	CABDBD	896	93	803	4	Steel	30				Rosga Well Co.	QBAA	
MNDH-CWI	122	670294	BENSON, STEVE		9277 367th Street North Branch MN 55056	35	21W	36	BCCCAC	898	160	738	4	Plastic	40	66	15	submersible	Schroepfer Well Drilling Inc.	QBAA	
MNDH-CWI	123	720533	SCHULTZ, DAVE		9533 367th Street North Branch MN	35	21W	36	BCDABA	898	156	742	4	Plastic	45	60		submersible	Lauren Mccullough Well Drilling	QABB	



- Proposed Test Well #1
- Site Location
- Section Lines

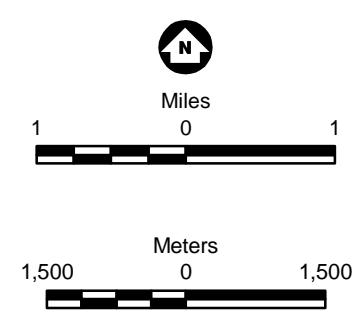
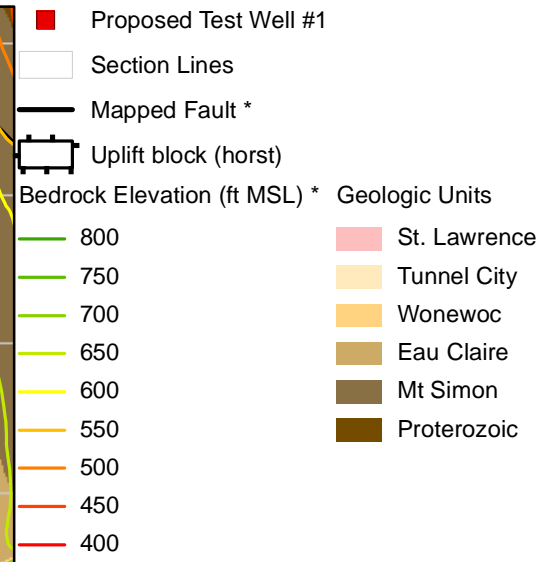
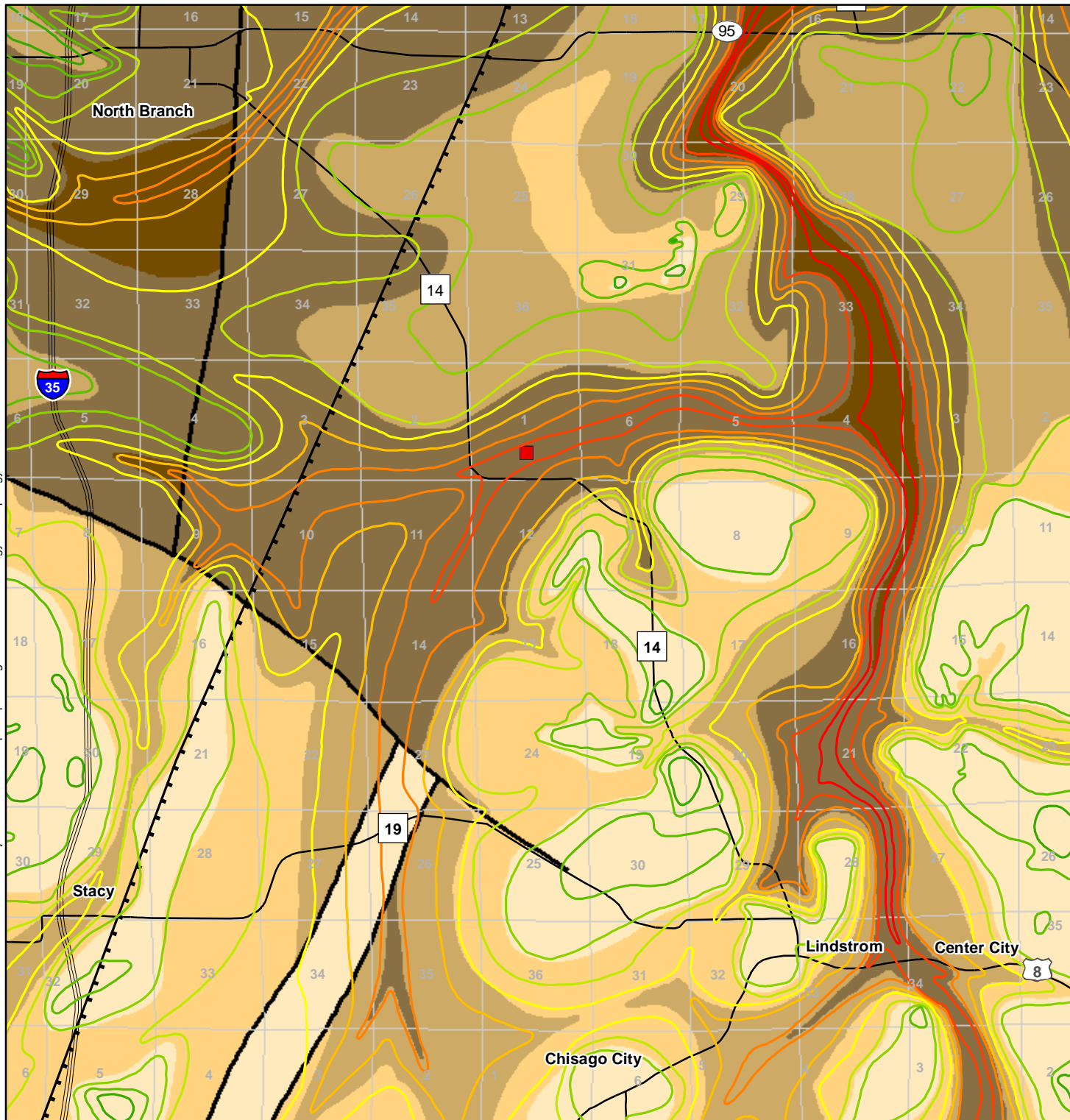


Figure 1
SITE LOCATION
 Sunrise River Energy Station
 LS Power Development, LLC
 Chisago County, MN



* Based on draft MGS data

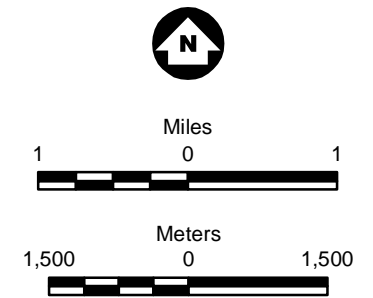
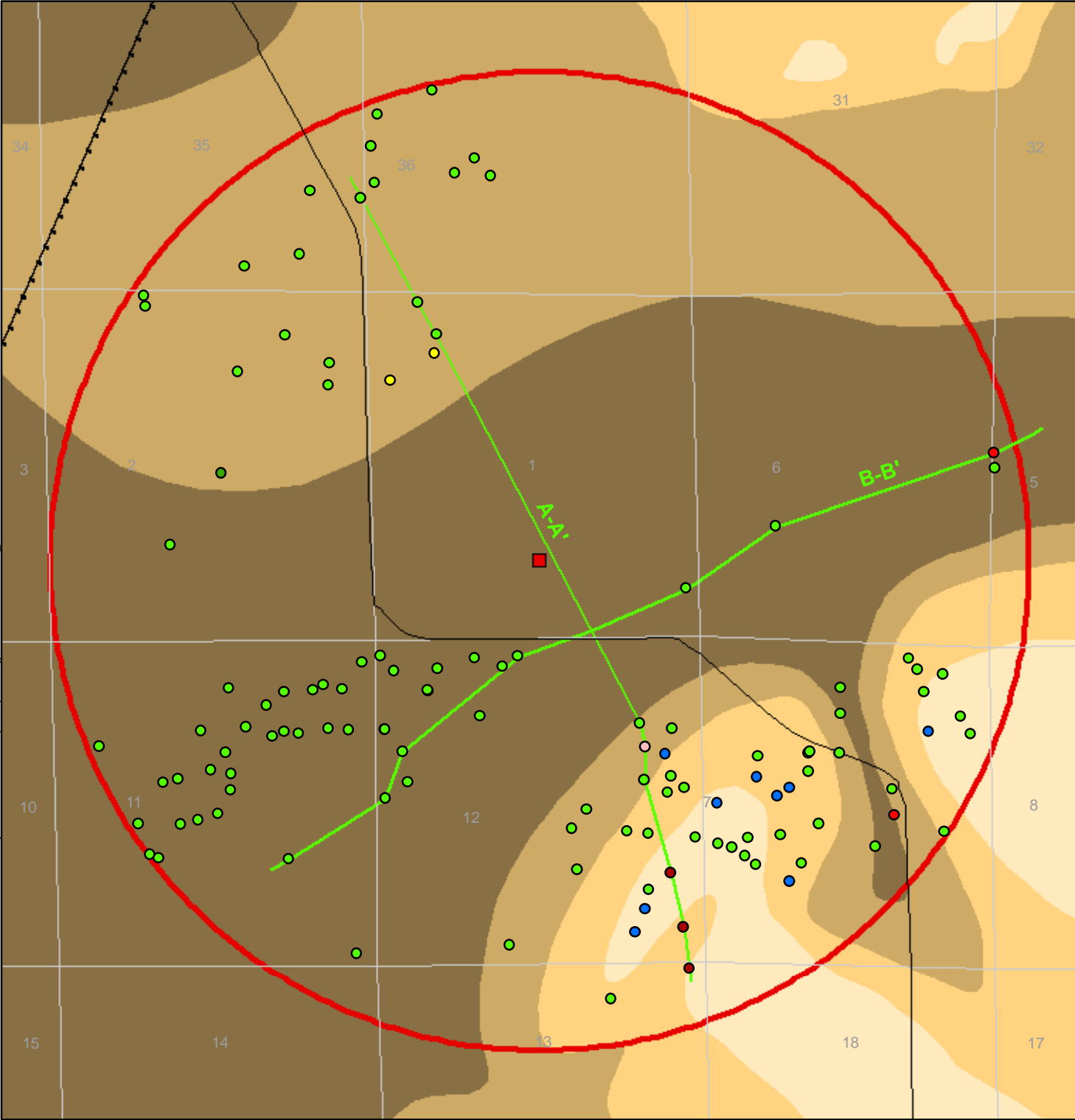


Figure 2
BEDROCK GEOLOGY
AND TOPOGRAPHY
Sunrise River Energy Station
LS Power Development, LLC
Chisago County, MN

Barr Footer: Date: 6/25/2009 3:31:18 PM File: I:\Projects\231131001\Maps\Reports\Figure 3 Wells Within 1.5 Miles.mxd User: arm2



- Proposed Test Well #1
 - Private Well, CWI
 - Unknown
 - Eau Claire
 - Eau Claire - Mt Simon
 - TC - Wonewoc
 - Mt Simon
 - Quaternary - Burried
 - Quaternary
 - Cross Section Location
 - Uplift block (horst)
 - 1.5-Mile Radius
- Geologic Units
- St. Lawrence
 - Tunnel City
 - Wonewoc
 - Eau Claire
 - Mt Simon
 - Proterozoic

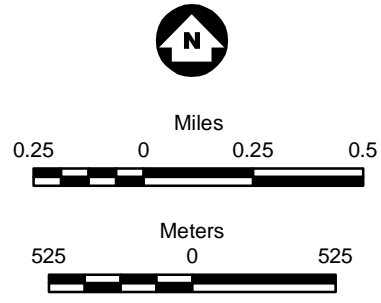
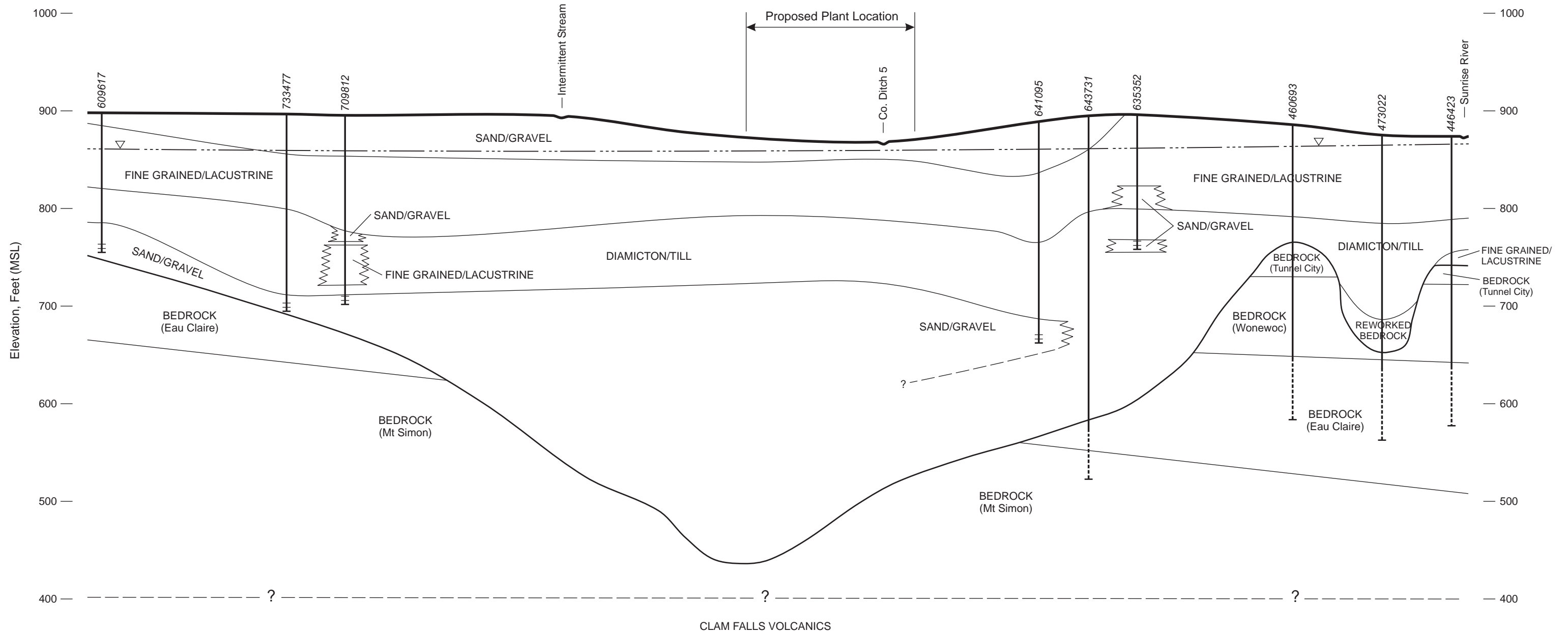


Figure 3
WELLS WITHIN 1.5 MILES OF
PROPOSED WATER SUPPLY WELL #1
WITH BEDROCK
Sunrise River Energy Station
LS Power Development, LLC
Chisago County, MN

A
NORTH

A'
SOUTH



LEGEND

- Ground Surface
- Geologic Contact (Dashed where inferred)
- Approximate Bedrock Surface (Based on draft MGS data and CWL logs)
- Water Table
- Well Screen Interval
- Well Open Interval

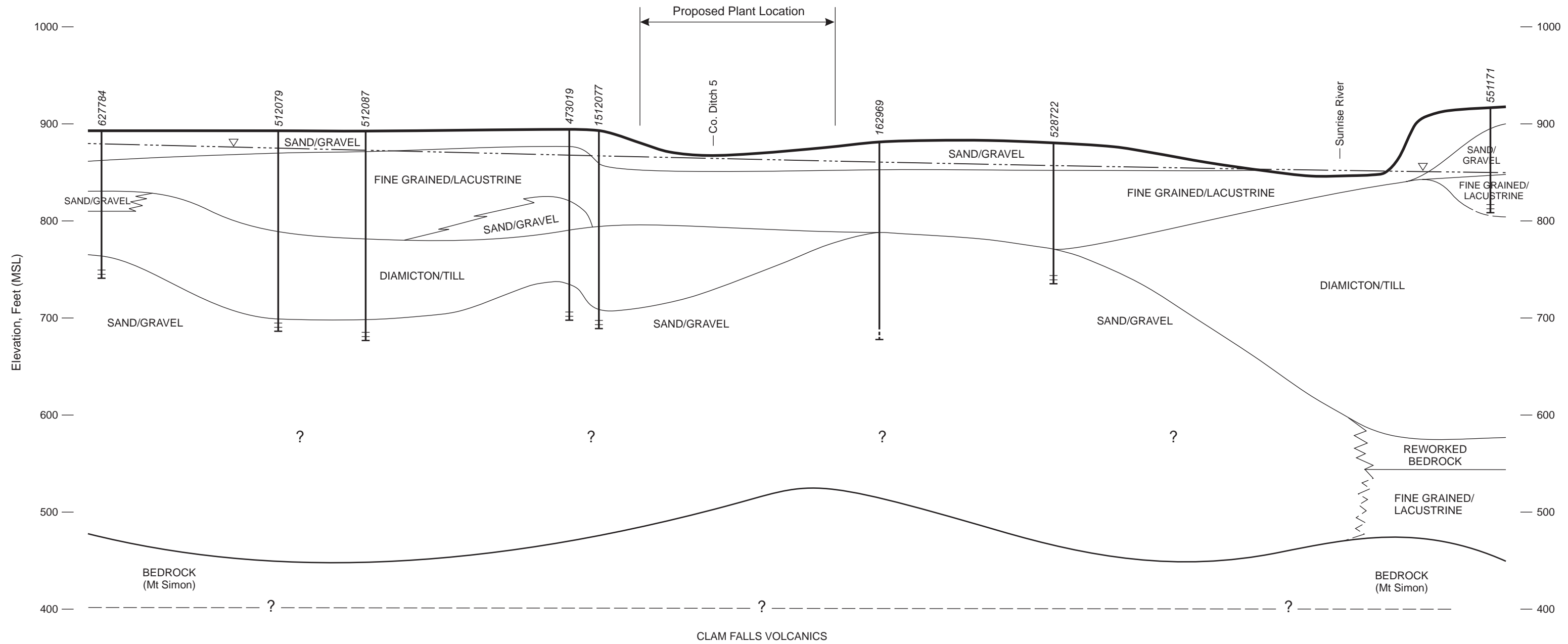
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 Approximate Horizontal Scale in Feet
 10X Vertical Exaggeration

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 Figure 4
 CROSS SECTION A-A'

Sunrise River Energy Project
 LS Power Associates, LP
 Chicago County, MN

B
WEST

B'
EAST



LEGEND

- Ground Surface
- Geologic Contact (Dashed where inferred)
- Approximate Bedrock Surface (Based on draft MGS data and CWL logs)
- Water Table
- Well Screen Interval
- Well Open Interval

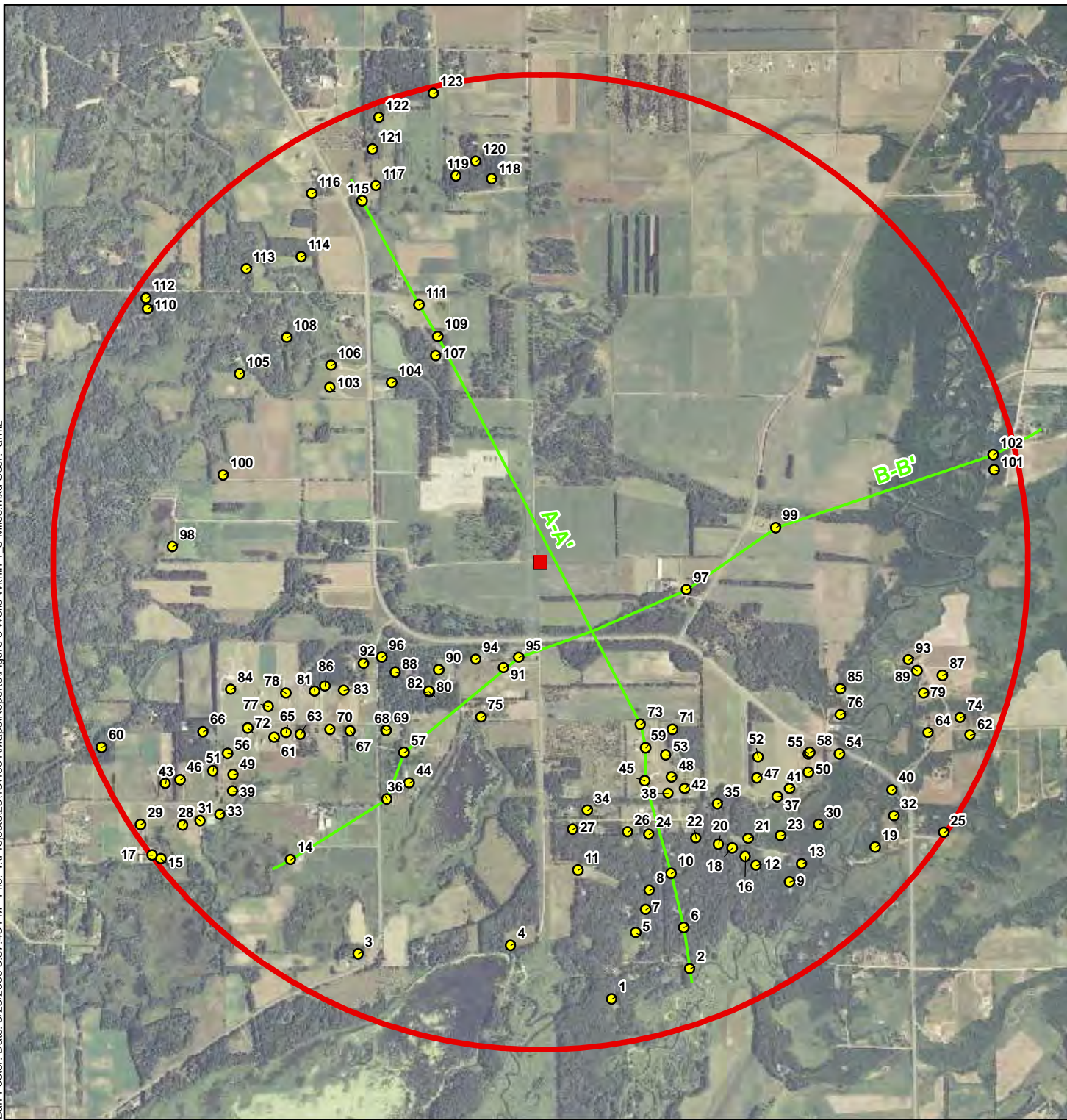
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Approximate Horizontal Scale in Feet
10X Vertical Exaggeration

DRAFT

Figure 5
CROSS SECTION B-B'

Sunrise River Energy Project
LS Power Associates, LP
Chicago County, MN



- Proposed Test Well #1
- Private Well, CWI (with Map ID Number from Table 1)
- Cross Section Location
- 1.5-Mile Radius

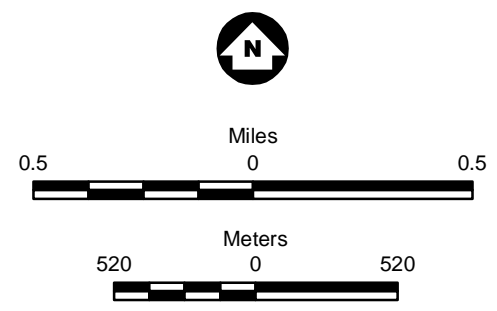
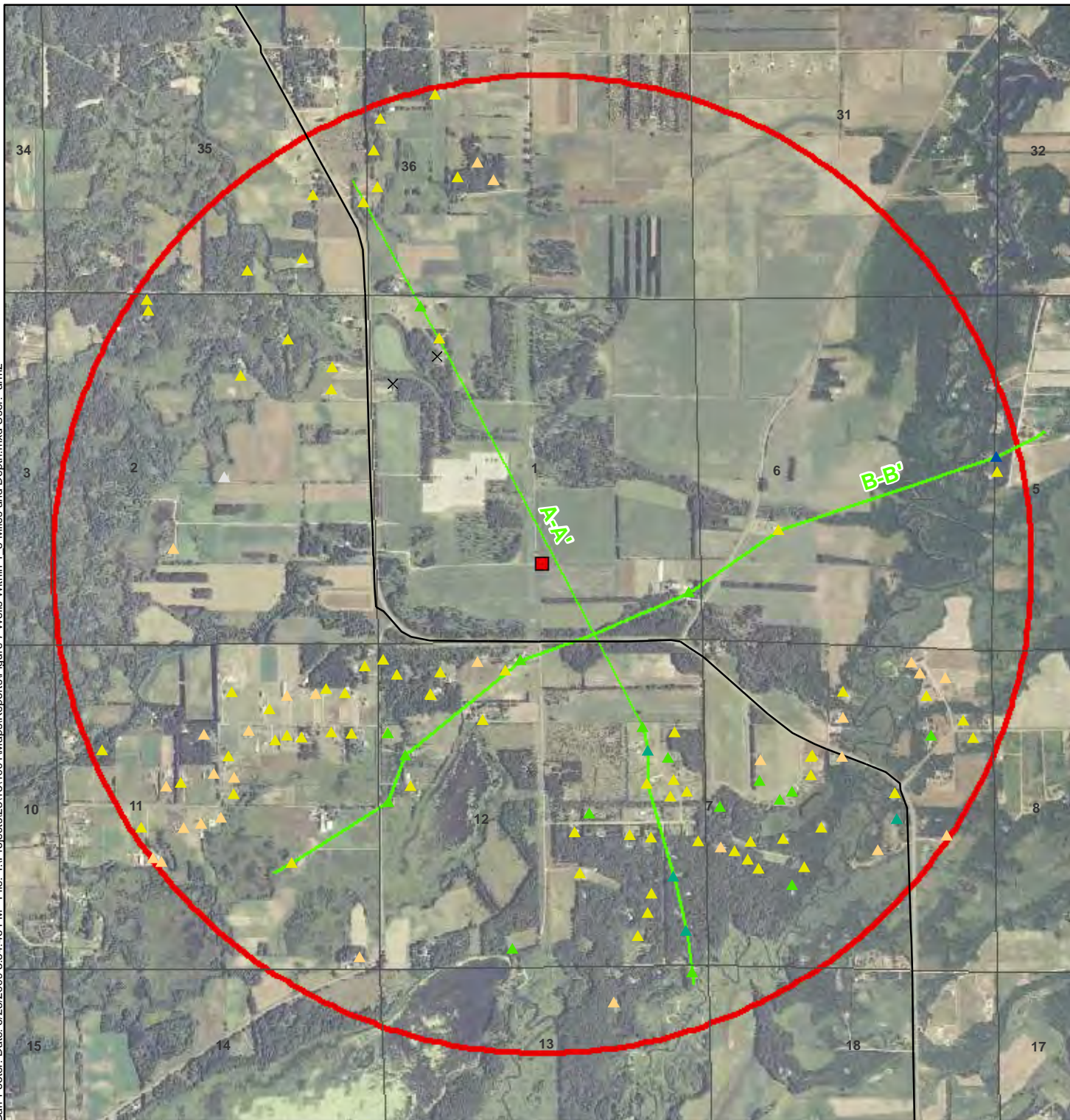


Figure 6
WELLS WITHIN 1.5 MILES OF
PROPOSED WATER SUPPLY WELL #1
Sunrise River Energy Station
LS Power Development, LLC
Chisago County, MN



- Proposed Test Well #1
- Private Well, Depth in Feet
 - × Unknown Depth
 - ▲ 10 - 49
 - ▲ 50 - 99
 - ▲ 100 - 199
 - ▲ 200 - 299
 - ▲ 300 - 399
 - ▲ 400 - 499
 - ▲ 500 - 600
 - ▲ 700 - 4000
- Section Lines
- ↗ Cross Section Location

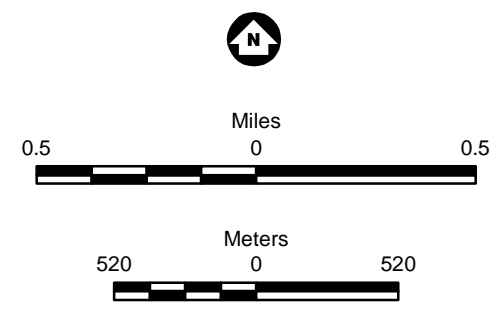


Figure 7
WELLS WITHIN 1.5 MILES OF
PROPOSED WATER SUPPLY WELL #1
WITH DEPTH OF WELL
Sunrise River Energy Station
LS Power Development, LLC
Chisago County, MN