

**WATER QUALITY  
IDYLVILDE HYDROELECTRIC PROJECT**



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January 20, 2011

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# **Water Quality**

## **Idylwilde Hydroelectric Project**

### **Introduction**

The City of Loveland, Colorado (City) is proposing to relicense Federal Energy Regulatory Commission (FERC) Project No. 2829, Idylwilde Hydroelectric Project (the Project). The Project is owned and operated by the City. Water Consult retained ERO Resources Corporation (ERO) to prepare preapplication materials associated with water quality for the proposed relicensing. This report addresses the requirements for a preapplication document described in FERC's Integrated License Application Process (18 CFR 5.6).

### **Project Description**

The Project is on the Big Thompson River along U.S. Highway 34 (U.S. 34), 14 miles west of the City (Figure 1). The dam is on National Forest lands managed by the Arapaho-Roosevelt National Forest. A hydroelectric plant was built on municipally owned property, allowing generation and distribution of energy from the Project to begin in 1925. The original dam and hydroelectric plant were destroyed in the Big Thompson River flood on July 31, 1976, and were subsequently rebuilt and returned to full service in 1981.

The dam is 50.5 feet high and has a total length of 239.1 feet. The reservoir has a surface area of 3.67 acres at spillway elevation, and impounds about 45 acre-feet of water. A minimum bypass flow of 7 cubic feet per second (cfs) is maintained through the dam to provide suitable habitat in the stream reach below. The penstock, 9,534 feet in length, originates at the dam and delivers water to two 450-kilowatt turbine-generator units in Loveland's Viestenz-Smith Mountain Park. The penstock crosses Forest Service and privately owned lands, and U.S. 34. Two taps along the penstock provide access to water for fire protection and 15 irrigation services are tapped into the line. The power generated is connected to the City's distribution system through a 22-kilovolt transmission line 1,153 feet in length.

### **Existing Environment**

#### **SURFACE WATER QUALITY STANDARDS, REGULATIONS, AND CLASSIFICATIONS**

The Colorado Water Quality Control Commission (WQCC) has adopted water use classifications for streams, lakes, and reservoirs that identify the uses to be protected on a stream segment or in a lake or reservoir, and adopted numerical standards for specific pollutants to protect these uses (Colorado Department of Public Health and Environment

(CDPHE) 2010a). The Big Thompson River from the boundary of Rocky Mountain National Park to the Home Supply Canal diversion downstream of the canyon mouth (listed as Segment 2 of the Big Thompson River basin by the WQCC); as well as Idylwilde Reservoir (Segment 16 of the Big Thompson River basin, which includes all lakes and reservoirs tributary to the Big Thompson River from the boundary of Rocky Mountain National Park to the Home Supply Canal diversion), are classified for the following uses:

- Aquatic Life Cold 1 (currently capable of sustaining a wide variety of cold water biota, including sensitive species, due to physical habitat, flows, or water quality conditions).
- Recreation Class E (surface waters used for primary contact recreation where the ingestion of small quantities of water is likely to occur, such as swimming and boating).
- Agriculture (suitable or intended to become suitable for irrigation of crops and not hazardous for livestock drinking water).
- Water supply (suitable or intended to become suitable for potable water supplies after receiving standard treatment).

The Big Thompson River in the Project area and Idylwilde Reservoir must be maintained and protected at their existing water quality unless it is determined by the WQCC that allowing lower water quality is necessary to accommodate important economic or social development in the area. No degradation is allowed unless deemed appropriate following an antidegradation review. Antidegradation review applies to the review of regulated activities with new or increased water quality impacts that may degrade water quality. Regulated activities mean any activities requiring a discharge permit or water quality certification under federal or state law.

Numeric standards for the Big Thompson River and Idylwilde Reservoir are provided in Table 1. There is no standard for phosphorus; however, the U.S. Environmental Protection Agency (EPA)-recommended concentration for streams is 0.1 mg/L (EPA 1986). For lakes or reservoirs, the recommended total phosphorus concentration to prevent or control eutrophication is 0.025 mg/L (EPA 1986). Eutrophication is an increase in the biological productivity of a lake or reservoir due to increased nutrient concentrations (generally nitrogen and phosphorus), which can result in a decrease in water clarity, reduced dissolved oxygen concentrations, degraded water quality, odors, and a decrease in fish and other aquatic life populations.

**Table 1. Numeric water quality standards for Big Thompson River from boundary of Rocky Mountain National Park to Home Supply Canal diversion and Idylwilde Reservoir.**

Parameter	Standard	Parameter	Standard
<b>Physical and Biological</b>		<b>Metals<sup>1</sup> (µg/L)</b>	
Dissolved oxygen (mg/L)	6.0	Aluminum (total, acute/chronic)	403.5/57.6
Dissolved oxygen, spawning (mg/L)	7.0	Arsenic (acute/chronic/water supply/agriculture)	340/150/0.02/100
pH (s.u.)	6.5-9.0	Cadmium (acute/chronic/water supply/agriculture)	0.31/0.13/5/10
Temperature <sup>2</sup> (maximum weekly average temperature, °C, Apr-Oct/Nov-Mar)	18.2/9.0	Chromium III (acute/chronic/water supply/agriculture)	158.7/20.6/50/100
Temperature <sup>2</sup> (daily maximum, °C, Apr-Oct/Nov-Mar)	23.8/13.0	Chromium VI (acute/chronic/water supply/agriculture)	16/11/50/100
<i>E. coli</i> (#/100 mL)	126	Copper (acute/chronic/water supply/agriculture)	3.1/2.4/1,000/200
<b>Inorganic (mg/L)</b>		Iron (chronic, total/water supply, diss)	1,000/300
Total ammonia <sup>3</sup> (acute/chronic)	6.77/2.8	Lead (acute/chronic/water supply/agriculture)	11.4/0.44/50/100
Chlorine (acute)	0.019	Manganese (acute/chronic/water supply/agriculture)	1,775/981/50/200
Chlorine (chronic)	0.011	Mercury (chronic/water supply)	0.01/2
Cyanide	0.005	Nickel (acute/chronic/water supply/agriculture)	125/14/100/200
Sulfide as H <sub>2</sub> S	0.002	Selenium <sup>4</sup> (acute/chronic/water supply/agriculture)	18.4/4.6/50/20
Boron	0.75	Silver (acute/chronic/water supply)	0.14/0.005/100
Nitrite	0.05	Zinc (acute/chronic/water supply/agriculture)	38.7/29.3/5,000/2,000
Nitrate	10		
Chloride	250		
Sulfate	250		

<sup>1</sup> Most aquatic life dissolved metals standards are hardness dependent; values provided in Table 1 assume a hardness of 21 mg/L for the Big Thompson River. Acute and chronic dissolved standards are for aquatic life. Water supply and agricultural standards are for total recoverable metals. Exceptions are aluminum, which has total recoverable standards for aquatic life; iron, which has a chronic total recoverable standard for aquatic life and a dissolved standard for water supply; manganese, which has a dissolved standard for water supply; and mercury, which has a chronic total standard for aquatic life.

<sup>2</sup> The maximum weekly average temperature (MWAT) chronic standard is defined by the WQCC as the largest mathematical mean of multiple, evenly spaced daily temperatures over a 7-day consecutive period, with a minimum of three data points spaced evenly throughout the day. The daily maximum (DM) acute temperature standard is defined by the WQCC as the highest 2-hour average water temperature recorded during a given 24-hour period. Temperature standards are Tier CS-II based on fish species present.

<sup>3</sup> The aquatic life acute ammonia standard is pH and temperature dependent; an average pH of 7.9 was used and an average stream temperature of 8.5°C was used for the Big Thompson River. Ammonia standards are lower when stream temperature and/or pH is higher.

<sup>4</sup> Selenium is a bioaccumulative metal, subject to a range of toxicity values depending on numerous site-specific variables.

Sources: CDPHE 2010a, CDPHE 2010c.

The nonattainment of water quality standards is reported every two years in the State of Colorado's 303(d) list (CDPHE 2010b). Stream segments, lakes, or reservoirs on the 303(d) list are considered impaired for one or more water quality parameters and a Total Maximum Daily Load (TMDL) is required to resolve the impairment. A TMDL is defined as a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources (EPA 2010). If an impairment is suspected and the data are not sufficient to draw a conclusion, the water segment is placed on the Monitoring and Evaluation (M&E) list. Segment 2 of the Big Thompson River is included in the state's 2010 303(d) list for copper, cadmium, zinc, and temperature; and on the M&E list for sulfide.

## **SURFACE WATER QUALITY**

Water quality data were compiled from the U.S. Geological Survey (EarthInfo 2008), Colorado Water Quality Control Division (Hillegas, pers. comm. 2010), and the Big Thompson Watershed Forum (Shelley, pers. comm. 2010). No water quality data, including temperature and dissolved oxygen concentrations, have been collected for Idylwilde Reservoir. However, water quality data have been collected in the Big Thompson River about 1.5 miles above the reservoir (USGS site 402554105202100, Big Thompson River above North Fork Big Thompson at Drake, Colorado) and about 3.6 miles below the dam (USGS site 06736700, Big Thompson River above Dille Tunnel near Drake, Colorado). The two sites have very similar water quality. The river is generally of excellent quality at both locations. Data collected from 2000 to 2009 show some water quality standard exceedances (Table 2). The following standard exceedances have occurred during the 2000 to 2009 period:

- pH slightly exceeded the standard (up to 9.2) in 2006 and 2007, once at the upstream location and three times at the downstream location during low-flow periods.
- *E. coli* counts exceeded the standard (as high as 600/100 mL) in 2004, 2005, and 2006; four times during June or July at the upstream location; and five times in July or September at the downstream location.
- Dissolved arsenic concentrations always exceed the total arsenic standard of 0.02 µg/L; the average dissolved arsenic concentration from 2000 to 2009 was 0.17 µg/L.
- Dissolved copper concentrations (as high as 5 µg/L) exceeded the acute aquatic standard twice at the upper location in June 2005 and October 2006, and once at the lower location in October 2006; and exceeded the chronic standard in 2005, 2006, 2007, and 2010 eight times at the upstream location and eight times at the downstream location.

- Dissolved lead concentrations (as high as 1.27 µg/L) exceeded the chronic aquatic standard twice in 2007 at the upstream location and once in 2007 at the downstream location.
- Dissolved silver concentrations exceeded the acute and chronic aquatic standards in 2004 five times from June through August at both locations (concentration was 0.2 µg/L during all of these sampling events).
- The daily maximum temperature standard of 23.8°C for April through October was never exceeded, but it is not possible to determine if the MWAT standard of 18.2°C for April through October was exceeded because temperatures were not measured more than once or twice per month. Single measured temperatures exceeded 18.2°C in July 2001, 2002, and 2006; and August of 2002, 2003, and 2006 at one or both locations

Whether chronic standards were actually exceeded for dissolved copper, lead, and silver is unknown because the samples were collected monthly and the elevated concentrations may not have been an ongoing chronic problem; however, the standards (CDPHE 2010c) state that both acute and chronic standards are not to be exceeded more than once every three years on average.

Of the 303(d)- and M&E-listed parameters, only copper was sampled at the sites upstream and downstream of Idylwilde Reservoir. Between 5 and 6 percent of the dissolved copper samples collected at the two locations exceeded the acute and/or chronic aquatic copper standard. Cadmium concentrations exceeded the acute aquatic life standard from 2003 to 2007 below a wastewater treatment plant near Estes Park and at Drake downstream of Miller Creek. Zinc concentrations exceeded the acute aquatic life standard from 2003 to 2005 at the same two locations and just below Lake Estes. The Colorado Water Quality Control Division does not have any recent sulfide data for the Big Thompson River at or near the Project area; therefore, the locations of past exceedances of the sulfide standard are unknown (Hillegas, pers. comm. 2010).

Most water quality parameters measured in the Big Thompson River at the upstream and downstream locations, including dissolved metals and some nutrients, do not show seasonal variation, except for the following parameters:

- Specific conductance, which is an indirect measurement of inorganic dissolved solids (e.g., chloride, nitrate, sulfate, phosphate, calcium, and sodium), is highest from November through April and lowest from late May through early July (during highest flows).
- Hardness, a measure of mineral content in water (primarily calcium and magnesium), is highest from February through April and lowest from late May through mid-July (during highest flows); during all times of the year, the water would be considered “soft,” meaning low in minerals.

- Alkalinity, defined as the total concentration of alkaline salts (bicarbonate, carbonate, and hydroxide) in water, is also highest from January through April and lowest from late May through mid-July.
- Total organic carbon is generally highest from late May through June as a result of snowmelt runoff.
- Dissolved oxygen concentrations are lowest in July and August when river temperatures are highest (but have remained above 7 mg/L).
- Dissolved orthophosphate concentrations are highest from November through February (as high as 0.2 mg/L).
- Dissolved ammonia concentrations are highest from December through March (as high as 1.8 mg/L).

**Table 2. Ranges of water quality concentrations for parameters measured between 2000 and 2009 in the Big Thompson River above and below Idylwilde Reservoir.**

Parameter	Big Thompson River near Drake (1.5 miles above the reservoir) <sup>1</sup>	Big Thompson River 3.6 miles below the reservoir <sup>2</sup>	Water Quality Standard
<b>Physical and Biological</b>			
Dissolved oxygen (mg/L)	7.1 - 14	7.5 – 13.9	6/7 (spawning)
Alkalinity (mg/L)	9 - 36	10 – 32	--
pH	7 – 9.1	7.1 – 9.2	6.5 – 9.0
Temperature (°C)	0 - 20	0 – 20	See Table 1
Specific conductance (µS/cm)	24 - 166	27 – 151	--
Turbidity (NTU)	<1 - 14	<1 – 11	--
Total organic carbon (mg/L)	2.4 – 9.5	1.9 – 9.6	--
<i>E. coli</i> (#/100 mL)	0 - 600	0 - 450	126/100 mL
<b>Inorganic (mg/L)</b>			
Total nitrogen	0.25 – 1.1	0.27 – 1.6	--
Total organic nitrogen	0.17 – 0.33	0.1 – 0.36	--
Dissolved ammonia	<0.002 – 0.682	<0.002 – 1.77	--
Total ammonia	NS	NS	6.77/2.8
Total ammonia + organic nitrogen	0.16 – 0.67	0.12 – 1.2	--
Boron	NS	NS	0.75
Chlorine	NS	NS	0.019 ac/0.011 ch
Cyanide	NS	NS	0.005
Sulfide as H <sub>2</sub> S	NS	NS	0.002
Dissolved nitrate + nitrite	0.01 – 0.94	<0.013 – 0.62	10 NO <sub>3</sub> /0.05 NO <sub>2</sub>
Dissolved orthophosphate	0.003 – 0.415	0.004 – 0.21	--



Parameter	Big Thompson River near Drake (1.5 miles above the reservoir) <sup>1</sup>	Big Thompson River 3.6 miles below the reservoir <sup>2</sup>	Water Quality Standard
Total phosphorus	0.013 – 0.167	0.011 – 0.155	0.1 (EPA recommended limit for streams)
Hardness at Ca CO <sub>3</sub>	8 - 37	9 – 33	--
Dissolved calcium	2.6 – 12.9	2.8 – 13.1	--
Dissolved magnesium	0.51 – 2.9	0.52 – 3.2	--
Dissolved sodium	1.4 – 12.7	1.4 – 9.3	--
Dissolved chloride	0.7 – 22.2	0.7 – 13.8	250
Dissolved potassium	0.27 – 2.4	0.35 – 1.5	--
Dissolved sulfate	1.5 – 8.8	1.8 - 12	250
<b>Dissolved Metals (µg/L)</b>			
Aluminum	NA	NA	No dissolved standard
Arsenic	0.08 – 0.3	0.1 – 0.3	340 ac/150 ch
Cadmium	NA	NA	0/31 ac/0.13 ch
Chromium	NA	NA	158.7 ac/206 ch Ch III 16 ac/11 ch Ch VI
Copper	0.7 - 5	0.7 – 4.5	3.1 ac/2.4 ch
Iron	13 – 169	20 – 126	300
Lead	0.03 – 1.27	0.04 – 0.45	11.4 ac/0.44 ch
Manganese	0.9 – 17.5	1.6 – 10.4	1,775 ac/981 ch
Mercury	<0.01 – 0.01	<0.02	0.01
Nickel	0.09 – 1.17	0.1 – 1.26	125 ac/14 ch
Selenium	0.05 – 0.2	0.05 – 0.3	18.4 ac/4.6 ch
Silver	<0.008 – 0.2	<0.008 – 0.2	0.14 ac/0.005 ch
Zinc	NA	NA	38.7 ac/29.3 ch

<sup>1</sup> USGS site 402554105202100, Big Thompson River above North Fork Big Thompson at Drake, Colorado.

<sup>2</sup> USGS site 06736700, Big Thompson River above Dille Tunnel near Drake, Colorado.

NS = parameter not analyzed for at this location.

-- indicates no numeric water quality standard.

## Idylwilde Reservoir Characteristics

The physical characteristics of Idylwilde Reservoir are provided in Table 3 (Howard, pers. comm. 2010).

**Table 3. Physical characteristics of Idylwilde Reservoir.**

Surface area	3.67 acres
Volume	45 acre-feet at normal maximum elevation
Maximum depth	38.5 feet
Mean depth	19 feet
Flushing rate	112/yr when at 45 acre-feet and bypassing 7 cfs
Shoreline length	2,643 feet
Substrate composition	sand

## **Potential Impacts**

Because reservoir operations will not change, there would be no effect to the existing water quality of the reservoir or of the Big Thompson River below Idylwilde Reservoir.

## **DIRECT AND INDIRECT IMPACTS**

Relicensing and continued operation of the existing Project facilities would not impact water quality.

## **CUMULATIVE IMPACTS**

The only reasonably foreseeable action is implementation of the Windy Gap Firming Project, which would slightly increase flows in the river in the Project area during some months (Table 4) in average flow years or wet years (Bureau of Reclamation 2007). This would be at most a 9 percent increase in the average monthly flow of the river. In April of a wet year there would be an estimated flow decrease of 1 cfs (a 1 percent decrease), but flows would not decrease during any other month or in April of an average flow year. There would be no changes in flows during a dry year. The increased flow would be brought through the Adams Tunnel to the Big Thompson River, and total nitrogen and total phosphorus concentrations would increase by less than 0.01 mg/L (Bureau of Reclamation 2007). The effect of this water on concentrations of other water quality parameters in the Big Thompson River has not been estimated, but is likely to be minor. The Project would not further increase total nitrogen, total phosphorus, or any other water quality concentrations.

**Table 4. Maximum possible monthly streamflow increase in Big Thompson River below Lake Estes due to Windy Gap Firing Project during an average or wet year.**

<b>Month</b>	<b>Predicted Monthly Flow Increase (cfs)</b>
November – March	0
April	1
May	15
June	19
July	18
August	3
September – October	1

## **MITIGATION MEASURES**

No mitigation measures are recommended for water quality.

## **Preliminary Issues and Recommended Studies**

### **PRELIMINARY ISSUES**

Preliminary issues are the effects that operation of the Project has on reservoir and downstream river temperatures, dissolved oxygen concentrations, and other water quality parameters, which could possibly affect aquatic life populations in or downstream of the reservoir. Due to the rapid flushing rate of the reservoir, there may be little effect to water quality in or downstream of the reservoir. However, there appear to be no temperature, dissolved oxygen, or other water quality data collected in Idylwilde Reservoir or immediately below the reservoir in the river to assess if the Project would alter water quality.

### **RECOMMENDED STUDIES**

It is recommended that reservoir temperature and dissolved oxygen data be collected monthly in Idylwilde Reservoir at various depths, such as at 5-foot intervals beginning at the reservoir surface to the bottom. These data will be used to create seasonal vertical profiles for the reservoir. In addition, it is recommended that water quality data be collected in the river downstream of the dam for comparison to water quality data collected upstream of the reservoir near Drake. Data to be collected should include nutrients (nitrogen and phosphorus), temperature, dissolved oxygen, pH, specific conductance, copper, cadmium, silver, and zinc. The metals are on the state 303(d) list and/or are of concern to aquatic life health. It is possible the reservoir may reduce the concentrations of these metals downstream of the reservoir due to settling out of the metals in the sediment on the bottom of the reservoir. It is recommended that such data

be collected on or near the same dates that data are collected at the site near Drake, in coordination with the Big Thompson Watershed Forum.

## **Agencies Contacted**

The agencies contacted for this report were:

Big Thompson Watershed Forum  
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U.S. Geological Survey

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City of Loveland

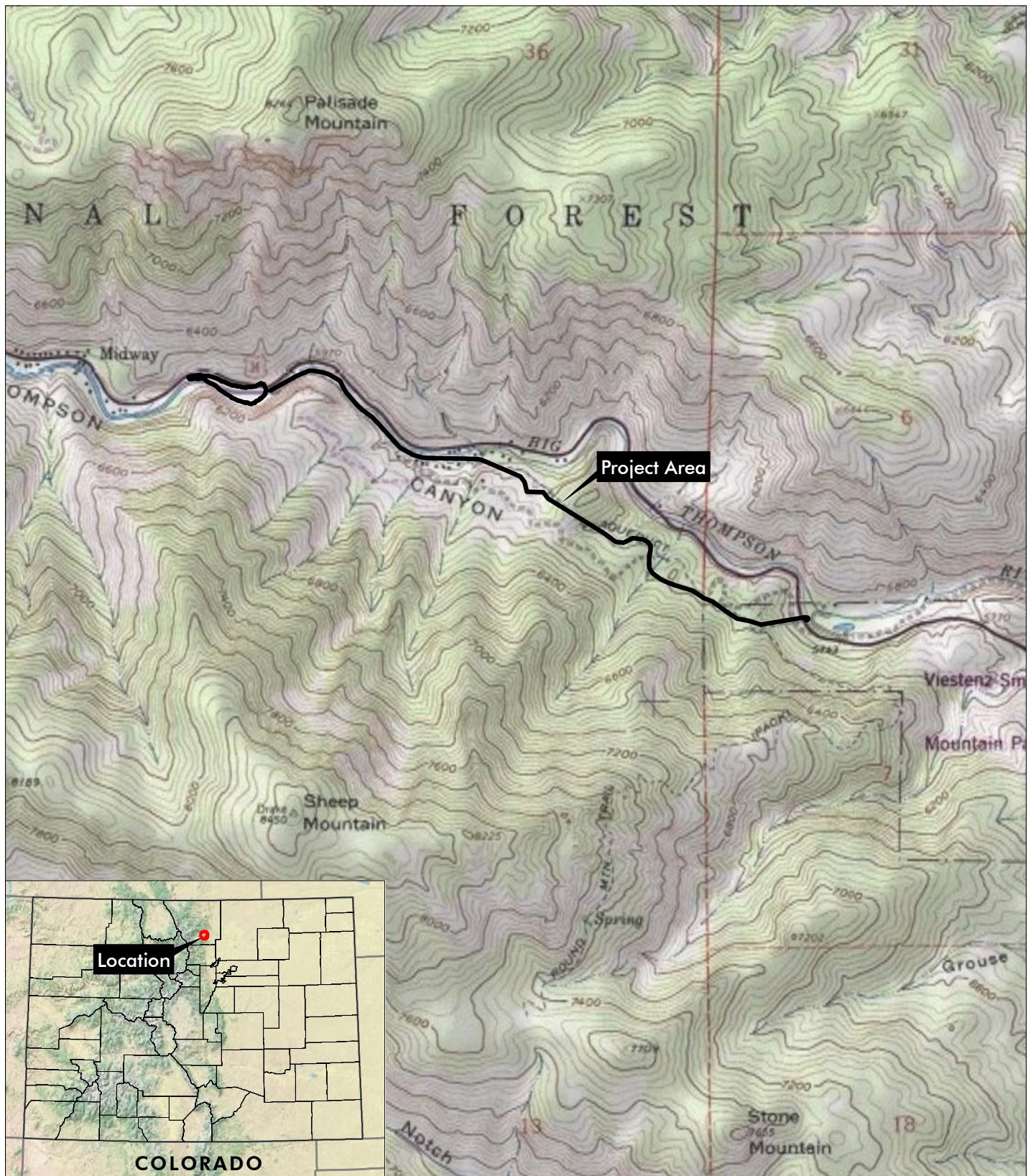
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### Idylwilde Hydroelectric Project

Sections 1 and 2, T5N, R71W; Section 7, T5N, R70W; 6th PM

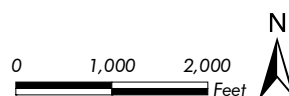
UTM NAD 83: Zone 13N; 474730mE, 4474958mN

Latitude, Longitude: 40.424874°N, 105.297895°W

USGS Drake, CO Quadrangle

Larimer County, Colorado

**Figure 1**  
**Site Location**



Prepared for: Water Consult  
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December 2010

**ERO**  
ERO Resources Corp.