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April 8, 2014

Lynn Van Every
Idaho Department of Environmental Quality
444 Hospital Way, Suite 300
Pocatello, ID 83201

Subject: Application for 401 Water Quality Certification – Bear River Narrows Hydroelectric Project - FERC No. 12486

Dear Secretary:

Twin Lakes Canal Company is requesting 401 Certification of their proposed Bear River Narrows Hydroelectric Project. We include through this letter and attachments information believed sufficient to provide reasonable assurance that the project will comply with the Clean Water Act and meet state water quality standards.

Legal name and address of activity owner or operator

Twin Lakes Canal Company
P.O. Box 247
Preston, ID 83263
(208) 852-1612
ATTN: Clair Bosen

Legal name and address of owner or operators authorized representative

Nicholas E. Josten
GeoSense
2742 Saint Charles Ave
Idaho Falls, ID 83404
(208) 528-6152

Names of waterbodies impacted by the project

Bear River

Complete written description of activity, including maps, diagrams and other information

See attached Exhibits A, B, F and G from the FERC license application.

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ENVIRONMENTAL QUALITY

Description of water quality impacts from the existing activities and proposed activities

See attached Exhibit E Section 7.3 from FERC license application.

Identification of measures to prevent or mitigate violations or contributions to violations of water quality standards

See attached Exhibit E Section 7.4 from FERC license application.

Copies of environmental information submitted to the federal licensing or permitting agency

See attached Exhibit E Sections 7.1 and 7.2 from FERC license application.

For convenience and ease of distribution the attachments have been provided in electronic format on CD. Please let me know if you need Twin Lakes to a submit hard copy versions of the application materials as well. If you have any questions about this application please feel free to call me at 208-528-6152.

Best regards,

N. E. Josten

Nicholas E. Josten
Agent for Twin Lakes Canal Company

Attachments
FERC No. P-12486 License Application Exhibit A, B, F, G
FERC No. P-12486 License Application Exhibit E, Section 7

Copies
Clair Bosen, Twin Lakes Canal Company
FERC, Washington DC

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Copies
Clair Bosen, Twin Lakes Canal Company
FERC, Washington DC

EXHIBIT A - DESCRIPTION OF THE PROJECT

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1 PROJECT FEATURES

The main construction features of the Bear River Narrows Hydroelectric Project are:

- New roller compacted concrete dam on the Bear River, 109 ft high in the center, 690 ft wide at the crest, 525 ft across at the base, with a crest elevation of 4,743 ft above sea level (ASL) and an open channel spillway crest at elevation 4,718 ft ASL operated by two radial gates (Exhibits F-3, F-4);
- New 4.5 mile[1] long reservoir behind the dam with a normal high water elevation of 4,734 ASL and a gross storage capacity of 12,647 acre-ft (Exhibit G-2, G-3);
- A 48-ft × 16-ft × 20-ft high concrete intake structure located near the upstream toe of the dam with a bar screen trash rack and sill elevation at 4,630 ft ASL (Exhibit F-5);
- A 600-ft long, 14-ft diameter steel penstock through the dam (Exhibit F-4);
- An 80-ft × 52-ft × 24-ft high powerhouse at the base of the dam, containing two 5.0 MW vertical Francis turbine/generator units, with a combined hydraulic capacity of 1,400 cfs (Exhibit F-2);
- New 0.1 acre electrical substation near the powerhouse and a 0.74 mile long 46 kV transmission line from the substation to the point of interconnect with an existing PacifiCorp transmission line (Exhibit G-2, F-6);
- New 0.1 acre pumping station with a 40 cfs pumping capacity located near the interconnect point to pump water from the Bear River into the Twin Lakes canal system (Exhibit G-2, F-8);
- New 3.1 mile long road beginning at Highway 36 to provide access to the reservoir and existing Oneida Dam (Exhibit G-2, G-3, F-5);
- A 1.2 mile extension of an existing road to provide access to an existing summer home area (Exhibit G-2);
- Two earthen cofferdams totaling about 700 ft in length to bypass river flow during construction of the intake and penstock and two earthen cofferdams totaling about 250 ft in length to dewater the dam area during embankment construction (Exhibit F-1);
- An 58 acre borrow area along the west edge of the reservoir to supply dam construction material (Exhibit G-2);
- A 9.3 acre construction staging area located downstream of the dam site and a 4.3 acre staging area located upstream of the dam site.

Twin Lakes Canal Company (Twin Lakes) also proposes mitigation actions to minimize adverse project impacts to public resources. These actions would be located on-site, downstream of the project area on the Bear River and on key tributaries, including Mink Creek. The mitigation plan, which is detailed in Appendix B, includes the formation of the Southern Middle Bear Watershed

[1] The length of the main channel of the Bear River, from the upstream limit of the impoundment as defined in Schiess and Associates (2009a) to the centerline of the proposed dam embankment as shown in Exhibit G of this application, was measured based on vector data contained in the National Hydrography Dataset (USGS, 2010) for the primary channel of the Bear River. The length of the impoundment measured by this method was 4.54 miles, which will be rounded off to 4.5 miles for the purposes of this application.

Commission to aid in oversight of the mitigation actions and to evaluate future project proposals that could be funded using an annual funding commitment by Twin Lakes. The primary elements of the mitigation plan are listed below.

Mitigation within the reservoir reach:

- Construct a new multi-use recreational facility (Exhibit F-7) and hiking trail;
- Create a fringe wetland/riparian habitat around the reservoir shoreline;
- Install a raptor nest platform and selected fencing to guide mule deer crossing of the reservoir;
- Operate the reservoir to absorb peaking flows and decrease downstream flow fluctuations;
- Implement an Erosion Control Plan and Noxious Weed Prevention and Revegetation Plan to minimize loss of existing wildlife habitat and to recover any habitat disturbed by construction.

Mitigation within the project reach below the dam:

- Construct a new 0.3 acre boater put-in site on the Bear River below the project powerhouse (Exhibit G-2, Exhibit F-1);
- Implement a Dissolved Oxygen Management Plan to assure that powerhouse discharges meet State of Idaho water quality criteria for dissolved oxygen at all times;
- Implement an Erosion Control Plan and Noxious Weed Prevention and Revegetation Plan to minimize loss of existing wildlife habitat and to recover any habitat disturbed by construction.

Mitigation on the Bear River downstream of the project:

- Acquire a 538-acre mitigation land parcel located about 12 miles downstream of the project area and place this property into trust or permanent easement for the benefit of aquatic, wetland, riparian, wildlife and recreational mitigation (Exhibit G-7);
- Construct a new boat ramp and river access facility on the Bear River within the mitigation site;
- Construct a parking area and hiking trail to provide access to 4.4 miles of Bear River shoreline for fishing within the mitigation site;
- Develop new wetland and riparian habitat throughout the mitigation site using the water right included with the property;
- Install two raptor nest platforms;
- Implement an Erosion Control Plan and Noxious Weed Prevention and Revegetation Plan to minimize loss of existing wildlife habitat and to recover any habitat disturbed by construction.

Mitigation on key Bear River tributaries:

- Implement a mandatory 10 cfs minimum flow on Mink Creek below the Twin Lakes diversion to be maintained on a year round basis (Exhibit G-5 and G-6), which will create new aquatic habitat and enhance existing aquatic and riparian habitat along a 4.2 mile corridor;
- Use a portion of the water right associated with the 538-acre mitigation property to provide a minimum flow in Battle Creek, subject to non-interference with existing water rights;
- Perform riparian and wetland plantings on upper Battle Creek at Winder and Condie reservoirs to enhance habitat for wildlife and increase recreational opportunities;
- Construct a nest platform or nest boxes on Deep Creek to increase wildlife habitat;
- Implement an Erosion Control Plan and Noxious Weed Prevention and Revegetation Plan to minimize loss of existing wildlife habitat and to recover any habitat disturbed by construction.

The project boundary and the locations of the major project facilities are shown in Exhibit G.

1.1 DAM

The proposed dam would be earthen constructed with a concrete spillway and overlayment of roller compacted concrete (RCC) designed to accommodate maximum probable flood flow of 74,900 cfs. Borrow material for dam construction would be extracted from an area adjacent to the dam site. The proposed dam would be 690 ft wide at the crest of the dam (from canyon wall to canyon wall) and 525 ft across at the base (from upstream toe to downstream toe). The crest elevation would be at 4,743 ft ASL, 9 ft above the reservoir normal high water elevation, 110 ft above the tailwater elevation and approximately 115 ft above the streambed on the downstream side of the dam (Exhibit F-4). The spillway would consist of a 40-ft wide concrete open channel with crest at 4,718 ft ASL. The spillway would be operated by means of two 20-ft wide radial gates (Exhibit F-3). When fully opened the spillway has the capability to release up to 4,890 cfs at normal high water.

Borrow material for dam construction would be extracted from an area upstream of the dam site and transported to the dam site by dump trucks. Roller/compactors would be deployed periodically to compact the fill material. The RCC cap on the downstream face of the embankment will be constructed in lifts concurrent with the placement of the embankment materials. Concrete for the RCC cap will be mixed in an on-site pugmill and moved into place using conveyors and conventional earth moving equipment. The concrete spillway will be formed and constructed integral with the RCC cap.

1.2 RESERVOIR

The dam would impound a new reservoir immediately downstream of the existing Oneida Dam. The reservoir would inundate 4.5 miles of the Bear River and would be 4.5 miles in overall length. The normal maximum water surface elevation for the new reservoir will be 4,734 ft ASL corresponding to a normal maximum water surface area of 362 acres and a gross storage capacity

of 12,647 acre-ft. Under normal operations the upper two feet of the reservoir could be used to buffer daily flow variations from the upstream Oneida Hydroelectric Project and thus would vary from 4,732 – 4,734 ft each day. During drought conditions, the reservoir may be drawn down 16 ft to 4,718 ft ASL, which corresponds to 5,000 acre-ft of storage. Reservoir specifications are summarized in Table A-1.

Table A-1. Specifications for the proposed reservoir.

RESERVOIR PARAMETER	VALUE
Normal maximum high water	4,734 ft ASL
Surface area at normal high water	362 acres
Capacity at normal high water	12,647 acre-ft
Shoreline length at normal high water	10.3 miles
Max depth at normal high water	100 ft
Mean depth at normal high water	50 ft

1.3 Intake Structure

The penstock intake structure would be constructed near the upstream toe of the dam and would include a bar screen trash rack with a clear space opening of 1.5 inches to prevent foreign materials from entering the penstock and passing through the turbines. The intake structure would consist of a 48-ft x 16-ft x 20-ft high concrete box resting on the bottom of the reservoir. The invert elevation of the intake would be at 4,630 ft ASL (see Exhibit F-5) and the top of the intake opening would be at elevation 4,650 ft ASL. When the reservoir is full (water level at 4,734 ft ASL) the intake would be from 84 to 104 ft below the water surface. When the reservoir is at maximum drawdown (water surface at 4,718 ft ASL) the intake would be from 68 to 88 ft below the water surface. The intake structure would be constructed on bedrock and anchored using rock anchors in the floor of the structure. Concrete for the structure would be mixed in an onsite batch plant and placed using concrete pump trucks.

1.4 Penstock

The penstock, consisting of a 600-ft long, 14-ft diameter spiral welded, 0.5-in. thick new steel pipe, would transport water from the reservoir to the turbines in the powerhouse. A trench would be excavated in the rock along the alignment of the penstock. The penstock would be installed in 40 ft sections in the rock trench. Pipe sections would be placed in position, welded in place and then encased in concrete. Concrete for penstock encasement would be mixed in an onsite batch plant and placed using concrete pump trucks. The hydraulic capacity of the penstock at normal high water is 3,350 cfs. The penstock would be lined inside and out with protective covering for cathodic protection, to minimize corrosion, protect against contamination, and improve flow characteristics. The penstock configuration is depicted in Exhibit F-1 and F-4.

1.5 Bypass and Cofferdams

The river bypass plan during construction consists of three phases (Exhibit F-1):

1. Divert the river to the east side of the island located near the middle of the proposed dam site using two 6-ft high x 20-ft wide cofferdams with a total length of about 700 ft. While channel is dewatered, construct the intake structure, penstock and powerhouse foundation, and outlet works.
2. Build a 150-ft long 10-ft high x-25 ft wide cofferdam at the intake structure to divert river flows through the penstock. Discharge into tailrace using a 48-in. fixed cone (Howell Bunger) valve, a 120-in. butterfly valve, and two turbine isolation valves in the powerhouse foundation (Exhibit F-2). Build a 100-ft long 6-ft high x 20-ft wide cofferdam to prevent water discharged into the tailrace from moving upstream and entering the dam construction site. The dam embankment would be built while water is diverted through the bypass system.
3. Remove the cofferdams and begin filling the reservoir using the fixed cone valve to regulate flows from 260 to 860 cfs (maximum flow is head dependent) and the 120-in. butterfly valve and/or turbine isolation valves for any additional required flow. Complete powerhouse construction under this bypass scenario.

The hydraulic capacities of the 120-in bypass valve and 48-in fixed cone valve are given in the table below.

UPSTREAM WATER ELEVATION (FT)	BY-PASS CAPACITY (CFS)		
	120-IN VALVE W/ 66" ORIFICE	48" FIXED CONE	TOTAL
4,650	505	330	835
4,660	637	425	1,062
4,670	746	500	1,246
4,680	840	550	1,390
4,690	926	620	1,546
4,700	1,003	690	1,693
4,710	1,076	740	1,816
4,720	1,144	770	1,914
4,730	1,208	810	2,018
4,734	1,232	830	2,062

1.6 Borrow Area

Construction materials for the project would be obtained from approximately 58 acres of borrow sources located on the west shore of the Bear River beginning at the dam site and extending for about 1 mile upstream (see Exhibit G-2). Borrow material would be taken from two locations, a 25-acre southern site located on private land immediately adjacent to the dam, and a 33-acre northern site located on BLM land about 1/2 mile north of the dam. Borrow material for the cofferdams and the dam embankment would be taken beginning at the southern site. After the borrow material has been exhausted at the southern site, borrow operations would move upstream to the northern site.

A maximum of approximately 740,000 cubic yards of borrow material would be taken from the two sites. Material would be removed to form a stable angle of repose on the hillside above the dam prior to final construction of the new summer home access road. At the end of construction the borrow area would be re-contoured as needed to stabilize slopes and then would be partially inundated by the reservoir. Twin Lakes would need to obtain a mineral permit for any borrow sources on BLM land and would need to pay for material removed from these BLM sources. An estimate of this cost has been included in the Exhibit D construction costs.

1.7 POWERHOUSE

The powerhouse would be 80 ft × 52 ft × 24 ft high. The powerhouse floor elevation will be 4,643 ft ASL with minimum tail water elevation at 4,633 ft ASL. The foundation would be constructed of reinforced concrete and the building would be constructed from prefabricated steel. Two 5.0 MW turbine/generator sets would be installed in the powerhouse with a combined flow capacity of 1,400 cfs (see Table A-2). A crane system would be installed to change turbines or generators out for repair or maintenance. Drawings showing the powerhouse and equipment are found in Exhibit F-2.

Table A-2. Specifications for the powerhouse generation equipment.

GENERATION PARAMETER	VALUE
Number of turbines	2
Turbine type	vertical Francis
Turbine hydraulic capacity	
Turbine No. 1 Min Max	 175 cfs 700 cfs
Turbine No. 2 Min Max	 175 cfs 700 cfs
TOTAL	1,400 cfs
Hydrostatic Head	
Maximum normal	101 ft
Mean head	100 ft
Design	101 ft
Turbine Capacity	
Turbine No. 1	5,250 KW (7,020 HP)
Turbine No. 2	5,250 KW (7,020 HP)
Generator Capacity	
Generator No. 1	5,000 KW (5,555 kVA, 0.86 Power Factor)
Generator No. 2	5,000 KW (5,555 kVA, 0.86 Power Factor)
TOTAL	10,000 KW

1.8 Substation and Transmission Line

A small transformation substation would be constructed adjacent to the powerhouse to step up voltage from 7.2 kV to 46 kV. A 0.74 mile, 46 kV three phase transmission line would connect the new substation to the existing PacifiCorp electrical grid. All proposed transmission lines would be designed to minimize raptor electrocution as suggested by U.S. Fish and Wildlife Service. The proposed electrical transmission route is shown on Exhibit G-2. Exhibit F-6 shows a single line electrical diagram of the power transfer from project to the electrical grid.

1.9 Pumping Station

A pumping station would be constructed near the transmission line interconnect to the existing PacifiCorp electrical grid. The pumping station would consist of two 800 HP pumps with a concrete intake structure and screened inlet. The hydraulic capacity of the pumping station would be adjustable from 0 - 40 cfs. The pumps would be used to pump water out of the Bear River and into the Twin Lakes canal network for irrigation use. The pumps would be manifolded together and connect to the existing 48-inch siphon on the west bank of the river. The pump station would consist of a 10 ft x 20 ft x 8 ft deep tapered concrete structure with two individual pump chambers. The river intake would consist of a 5 ft x 20 ft x 5 ft deep screened collection gallery constructed slightly above the bottom of the river channel that would allow debris, fish and ice to pass over the top. The floor of the collection gallery and pump station intake would slope gently toward a low point in the sump. The collection gallery would be constructed with wingwalls and the river bank armored with riprap to prevent erosion. A small access road and parking pad would be constructed on the north side of the pump station. An electrical transformer would be located inside the fenced area with an underground service running under the existing road to the interconnect location. Exhibit F-8 shows preliminary drawings of the pump station.

The pumping station is an irrigation facility and is not required to operate the hydropower project; however pumping station operations would be synchronized with operation of the new reservoir and with bypass flows at the Twin Lakes diversion on Mink Creek. The pumping operation may therefore be viewed as a cumulative effect on Bear River water flow and is described in that context in Exhibit E.

1.10 Reservoir Access Road

A new road would be constructed beginning at Highway 36, extending for 3.1 miles and ending near Oneida Dam where it would tie into the existing Oneida Narrows Road. This road would provide access to Oneida Dam and the new reservoir. The road would be built to Franklin County Class D standards, would have a maximum grade of 8% and would have turning radii adequate to accommodate a semi tractor and trailer. The construction process would consist of clearing, grading and leveling the road route using bulldozers and graders. Gravel would be hauled to construct the road in dump trucks and leveled by graders and roller/compactors. The location of the proposed access road is shown in Exhibits G-3 and G-4 and a typical road cross section is shown in Exhibit F-5. The final road alignment shown in Exhibit G has been adjusted slightly from the alignment presented in Study 18 of the approved FERC Study Plan (Schiess & Associates, 2009c).

The primary changes from the Study 18 alignment are an adjustment of the grade and turning radius in the lower road section to accommodate PacifiCorp concerns and an adjustment of the upper road to minimize grade. The largest deviation from the Study 18 road alignment is about 300 ft.

1.11 Summer Home Access Road

A new 1.1 mile gravel road would be constructed beginning just below the dam, branching from the main Oneida Narrows Road that currently runs from State Highway 36. The new road would climb past the right dam abutment and extend upstream to intersect with an existing road that currently provides access to a summer home area on the west side of the new reservoir. This road would be used to access the dam and powerhouse facilities. Private-only access will be provided for summer home users. Much of the access road will be cut into the hillside. Talus overburden would be removed as necessary to create stable slopes above and below the access road. The location of the proposed summer home road is shown in Exhibit G-2. The summer home access road would be subject to partial closure and periodic re-routing during construction of the new dam (see Exhibit E, Land Use) but summer home traffic would be accommodated at all times.

1.12 Multi-use Recreation Facility

A new day-use/camping area and boat ramp would be constructed on the east side of the reservoir approximately 0.75 miles north of the existing Red Point Campground, which would be inundated by the reservoir. The new recreation facility would include restroom facilities and a group site with a shelter. The footprint of the recreation site would be approximately 4.1 acres (Exhibit F-7). The restroom, group site and one of the regular camping sites would be ADA accessible. The boat ramp would extend to the proposed low-water lake level and would be usable at full reservoir drawdown of 5,000 acre-ft. The existing 1.8 mile long road segment between the recreation area and the new reservoir access road would be locally inundated by the new reservoir. Therefore the existing road would be re-aligned as needed for road access to the recreation site.

1.13 Boater Put-In

A boater put-in with a gravel parking area for up to 8 vehicles would be constructed below the new hydroelectric powerhouse. The boater put-in would consist of a foot path leading to a gravel and rip-rap armored river bank section and would accommodate rafts, kayaks, inner tubes and other portable floating craft.

1.14 Conservation Parcel

Twin Lakes proposes to acquire the Johnson Family Farm Site, a 538 acre property on the Bear River 12.7 miles below the proposed dam that includes a significant water right. The site is currently used for a cattle operation. Twin Lakes proposes to develop the property to benefit aquatic, wetland and riparian habitats; fisheries and wildlife habitat; recreational opportunities; and ecosystem function. The conceptual plan identifies 138 acres of existing aquatic and wetland habitat on this parcel. Enhancement actions will create at least 47 acres of new wetland habitat and

38 acres of new riparian habitat as well as enhancing existing wetland and riparian habitats. The details of this conservation development proposal are presented in Appendix B.

1.15 Boater Put-In / Take-Out and Public River Access

A boater put-in / take-out with accommodations for both portable and trailer-deployed boats would be constructed approximately 13 miles downstream of the hydroelectric powerhouse as part of the conservation parcel described above. A new access road, parking area, boat launch, and bathroom facility would be constructed for sportsman access to the Bear River east of Highway 91. New public access would also be provided west of Highway 91 with a road, parking area and hiking trail providing full access to the site including 4.4 miles of Bear River bank access. Additional details of these recreation developments are presented in Appendix B.

1.16 Mink Creek Diversion

As a mandatory condition for hydropower operation Twin Lakes proposes to bypass water at its Mink Creek diversion dam as needed to maintain a year-round 10 cfs flow in Mink Creek. This measure would provide year-round connectivity between the Bear River and the Bonneville cutthroat trout stronghold in upper Mink Creek, maintaining valuable permanent fishery habitat. Twin Lakes Canal Company's Mink Creek diversion consists of a 43-in high concrete overflow weir that forms a small (< 0.1 acre) forebay pool to drive water withdrawal through three sets of gates. One single 5-ft wide bypass gate releases water downstream into Mink Creek. Four 5-ft wide gates on the north side of the forebay feed water into the Twin Lakes Canal Company main canal. Two 5-ft wide gates located on the south side of the forebay feed water into a Consolidated Irrigation Company canal. Drawings and photographs of the existing Mink Creek diversion structure are provided in Exhibit F-9 and Appendix D. The diversion structure would not be modified under the proposed project since the existing 5-ft wide bypass gate is capable of releasing the proposed minimum flow. The flow released into Mink Creek would be monitored at a new gauging station installed at a suitable location downstream from the dam.

2 Federal Lands

Table A-3 shows all land ownership within the Exhibit G project boundary designated by quarter-quarter section. Table A-4 shows Federal land acreages. If successful in obtaining a FERC license, Twin Lakes would apply for a right-of-way authorization for activities requiring use of BLM lands.

Table A-3. Land ownership for Bear River Narrows Hydroelectric Project.

PROJECT ELEMENT	LOCATION	OWNER FEDERAL AGENCY	OTHER PRIVATE ENTITY	PRIVATE
Substation	NW1/4 NE1/4 S21 T14S R40E			Lyle Bosen
Transmission	NW1/4 NE1/4 S21 T14S R40E W1/2 SE1/4 S16 T14S R40E SW1/4 NE1/4 S16 T14S R40E		PacifiCorp PacifiCorp PacifiCorp	Lyle Bosen

PROJECT ELEMENT	LOCATION	OWNER FEDERAL AGENCY	OTHER PRIVATE ENTITY	PRIVATE
Dam and Powerhouse	S1/2 NE1/4 S16 T14S R40E		PacifiCorp	
Borrow Area	E1/2 NW1/4 S16 T14S R40E			B. Smith
	W1/2 NE1/4 S16 T14S R40E		PacifiCorp	
	E1/2 SE1/4 S9 T14S R40E	BLM		
	W1/2 SW1/4 S10 T14S R40E	BLM		
Reservoir	NE1/4 S16 T14S R40E		PacifiCorp	
	NW1/4 NW1/4 S15 T14S R40E	BLM		
	SE1/4 SE1/4 S9 T14S R40E	BLM		
	W1/2 SW1/4 S10 T14S R40E	BLM		
	NE1/4 SW1/4 S10 T14S R40E	BLM		
	NW1/4 S10 T14S R40E	BLM		
	SE1/4 SW1/4 S3 T14S R40E	BLM		
	W1/2 SE1/4 S3 T14S R40E	BLM		
	NE1/4 SE1/4 S3 T14S R40E	BLM		
	E1/2 NE1/4 S3 T14S R40E	BLM		
	NW1/4 SW1/4 S2 T14S R40E	BLM		
	W1/2 NW1/4 S2 T14S R40E		PacifiCorp	
	E1/4 S34 T13S R40E	BLM		
	W1/4 S35 T13S R40E		PacifiCorp	
	NE1/4 NW1/4 S35 T13S R40E		PacifiCorp	
	S1/2 SW1/4 S26 T13S R40E		PacifiCorp	
	NE1/4 SW1/4 S26 T13S R40E		PacifiCorp	
	SE1/4 NW1/4 S26 T13S R40E		PacifiCorp	
Access Road	SE1/4 NW1/4 S26 T13S R40E		PacifiCorp	
	SW1/4 NE1/4 S26 T13S R40E		PacifiCorp	W. Smith
	NW1/4 NE1/4 S26 T13S R40E		PacifiCorp	
	SE1/4 NE1/4 S26 T13S R40E			Hobbs
	NE1/4 NE1/4 S26 T13S R40E		PacifiCorp	
	NW1/4 NW1/4 S25 T13S R40E			W.Smith, Hobbs
	NE1/4 NW1/4 S25 T13S R40E			Hobbs
	NW1/4 NE1/4 S25 T13S R40E			Hobbs
	SW1/4 SE1/4 S24 T13S R40E			Hobbs
	SE1/4 SE1/4 S24 T13S R40E			Free
	E1/2 NE1/4 S25 T13S R40E			Free
	SW1/4 NW1/4 S30 T13S R41E			Free
	SE1/4 NW1/4 S30 T13S R41E			Free, Hickman
	NW1/4 NE1/4 S30 T13S R41E			Free
	SW1/4 NE1/4 S30 T13S R41E			Hickman
Mink Creek Diversion	SW1/4 SE1/4 S1 T14S R40E			Keller

PROJECT ELEMENT	LOCATION	OWNER FEDERAL AGENCY	OTHER PRIVATE ENTITY	PRIVATE
Conservation Parcel	SE1/4 NW1/4 S8 T15S R39E			Johnson
	E1/2 NE1/4 S8 T14S R39E			Johnson
	SW1/4 NE1/4 S8 T14S R39E			Johnson
	E1/2 SW1/4 S8 T14S R39E			Johnson
	SE1/4 S8 T14S R39E			Johnson
	NW1/4 NW1/4 S9 T14S R39E			Johnson
	S1/2 NW1/4 S9 T14S R39E			Johnson
	NW1/4 SW 1/4 S9 T14S R39E			Johnson
	NE1/4 S17 T14S R39E			Johnson

Table A-4. Federal land acreages within the project boundary.

ACREAGE CATEGORY	ACRES
Total acreage in project boundary	1196
Total acreage in project boundary excluding conservation parcel	658
Federal acreage in project boundary	243

3 PRIVATE LANDS

Table A-5 lists all private land acreages within the Exhibit G project boundary. If successful in obtaining a FERC license, Twin Lakes would seek to purchase or lease these private lands as needed to develop the project. Estimated land acquisition costs have been included in the Exhibit D financial analysis.

Table A-5. Private land acreages within the project boundary.

LANDOWNER	ACREAGE WITHIN PROJECT BOUNDARY	PROJECT ELEMENT
Johnson	538	conservation parcel
PacifiCorp	353	upper reservoir, lower reservoir, hydro facilities
Lyle Bosen	28.4	staging area
Hobbs	16.2	main access road
Free	8.0	main access road
W. Smith	5.4	main access road
Hickman	1.6	main access road
B. Smith	1.1	borrow area
Keller	0.3	Mink Creek diversion

WORKS CITED

Schiess and Associates. (2009a). *Study 13 Reservoir Capacity and Evaporative Loss Study Final Report.* Preston, ID: Twin Lakes Canal Company.

Schiess and Associates. (2009c). *Study 18 Access Road Feasibility Study Final Report.* Preston, ID: Twin Lakes Canal Company

EXHIBIT B - PROJECT OPERATION AND RESOURCE UTILIZATION

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1 INTRODUCTION

Twin Lakes Canal Company's primary need for the Bear River Narrows Hydroelectric Project is to provide additional irrigation water to its shareholders. Twin Lakes Canal Company cannot consistently deliver adequate water to shareholders due to lack of storage facilities and shortcomings of the existing water conveyance network. The project supplies two crucial elements toward satisfying this need: 1) it provides a physical location to store additional water that is geographically connected with the existing Twin Lakes' water rights and water conveyance system, and 2) it constitutes a revenue source to fund improvements to conveyance facilities as needed to take advantage of existing water rights. These specific needs can only be met by locating a combination hydropower/water storage facility within the agricultural operations area of Twin Lakes Canal Company.

The final dam site selected was originally identified by Bureau of Reclamation in 1960 (Calder, 1960a). Reclamation reported this location to have the ideal combination of geology, power production capacity, and irrigation water delivery potential. After its own investigation, Twin Lakes concurred with this conclusion. Once the final dam site was selected, various options were considered for the normal operating elevation of the reservoir. The high water mark of the reservoir determines the maximum hydraulic head and therefore influences power production. An elevation of 4,734 ASL was selected as the normal maximum water elevation based on a detailed analysis of potential impacts to the tailrace of Oneida Dam (Schiess and Associates, 2009b). The selected reservoir elevation obtains the maximum head for the proposed project without adverse impacts to Oneida.

The applicant is preparing a detailed alternative evaluation that describes the basis for selecting the Bear River Narrows as the best location to construct a project to meet the canal company's primary need. This document is being prepared as part of the applicant's Section 404 consultation with the U.S. Army Corps and will also be filed with FERC.

2 PROJECT OPERATION

The default plant operation mode would be run-of-reservoir, with manual start up, automatic operation, and automatic shut down. Head level control would be used to automatically adjust flow through the turbines to match inflow into the reservoir, thus maintaining a constant reservoir water surface elevation. This method assures that water released from the Narrows project into the Bear River would exactly match the minimum flow requirements of the upstream Oneida Project (FERC No. 20)[1]. In the event that inflow exceeds turbine capacity or the power plant goes offline, automatic bypass gates would open to release additional water, assuring that downstream water delivery would not be interrupted. If reservoir inflow exceeded hydraulic capacity of the combined turbines and bypass, excess water would overflow the dam spillway.

Alternatively, the project could be operated in a manual mode as a means to level out flow fluctuations from Oneida Dam and provide more uniform flows in the Bear River downstream of the new project. In this mode, an optimal release schedule would be determined based on scheduled releases from Oneida Dam. The desired amount of water would be released regardless of reservoir inflow, thus providing stable flows in the Bear River downstream. Inflow fluctuations would be absorbed into the reservoir causing a slight up and down change in the water level over the course of a day. The release schedule would be set so that the total water released each day from Oneida and Bear River Narrows would be the same and would include a requirement to maintain a minimum flow at the Narrows project equal to the minimum flow requirement at the upstream Oneida project.

During dry years Twin Lakes would have the option to release up to 5,000 acre-ft of irrigation water from storage in the new reservoir during the summer and refill the reservoir during the winter. Whenever irrigation water was being actively stored or released the project would be operated in a manual mode. Water flow released from the reservoir would be adjusted as needed to accomplish the desired storage or withdrawal consistent with Twin Lakes' water rights. To prevent excessive reservoir drawdown due to persistent dry weather conditions over multiple years Twin Lakes proposes a maximum drawdown limit of 5,000 acre-ft. The drawdown limit would set a mandatory lower limit on the reservoir water level at 4,718 ft ASL and would prevent the reservoir from being excessively drained in the event that winter-spring Bear River flows are not adequate to fully refill the reservoir prior to the beginning of each new irrigation season. During all manual operations Twin Lakes would agree to always maintain a minimum flow at the Narrows project equal to the minimum flow requirement at the upstream Oneida project. In order to use any water released from storage Twin Lakes would need to pump the water back out of the river and into the Twin Lakes canal system at the new pumping station located 0.7 miles downstream of the dam.

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[1] The FERC license for the Oneida development (FERC No. 20) requires PacifiCorp to release a year-round minimum flow equal to a) 250 cfs plus 1 cfs leakage, or b) inflow into Oneida Reservoir, whichever is less.

During automatic or manual operation, efforts would be made to maximize the overall plant production and efficiency. Common maintenance items would be stocked on site in order to minimize unscheduled down time. In order to minimize down time, a special call up feature would notify the operator(s) at home of preset alarms or unscheduled shutdowns. Also, in order to maximize operating efficiency, turbines, generators, and lubrication systems would operate independently, thus allowing maintenance on one turbine/generator while the other is in production. All turbine/generator equipment and associated switchgear would be of utility grade, thus ensuring dependable use.

2.1 Expected Plant Output

Energy calculations were performed to account for the following factors:

- Variation in flow releases from Oneida;
- Variation in tailwater elevation;
- Variation in flow releases and reservoir elevation due to optional reservoir drawdown for irrigation;
- Flow-dependent friction losses in penstock;
- Flow-dependent efficiency of turbine/generators.

Flows through the Bear River Narrows Project site would be governed by releases from the upstream Oneida Dam, which is operated by PacifiCorp under a Dec-2003 FERC license (FERC No. 20). Releases from Oneida Dam are determined by the availability of water, the demand for power, and requirements for meeting irrigation commitments (PacifiCorp, 2004). Figure B-1 shows average monthly releases from Oneida Dam (USGS Gauging Station 10086500) for average, high, and low water years during the time period from 1958 – 2010. Figure B-2 shows the annual flow duration curve for the same period of record. Figures B-3, B-4 and Table B-1 show monthly flow duration statistics. These data were the basis for calculating energy production and dependable capacity.

Hydraulic head for power production is determined by the water level in the reservoir and the water level in the powerhouse tailrace. Figure B-5 is an elevation-capacity curve for the proposed reservoir based on topographic data collected in 2008 (Schiess and Associates, 2009a). In the default operation mode, the reservoir would be operated to maintain a constant elevation of 4,734 ft ASL at all times including low water years. Evaporative losses would be made up downstream of the reservoir using Twin Lakes water rights on Mink Creek (see Exhibit E, Section 6 – Water Quantity) and would not affect the reservoir water level. Hydraulic head and power production would be somewhat reduced in the optional operating mode where Twin Lakes elects to drawdown the reservoir to meet irrigation demand in low water years.

Figure B-6 is the tailwater rating curve. At maximum turbine capacity (1,400 cfs) the tailwater elevation would be about 4,635.9 ft ASL and total head would be about 98.1 ft. Assuming constant reservoir elevation, head would vary from about 96 ft to about 101 ft over the normal range of flow conditions. Head would be slightly reduced at higher flows and slightly increased at lower flows.

Figure B-7 shows the project's generating capacity over the range of expected flow conditions with the reservoir water level at 4,734 ft ASL. The peak power output occurs at a flow of 1,400 cfs, which is the hydraulic capacity of the turbines. At flows above 1,400 cfs the power output decreases due to reduced head as the tailwater elevation rises. The 1,400 cfs hydraulic capacity corresponds to just less than the 18% exceedance flow (Figure B-2). The project dependable capacity is 2.0 MW assuming the default operating mode (full reservoir). The dependable capacity is based on the 90% exceedance flow (275 cfs) from Figure B-2.

Using flow records from 1958 to 2010, the average annual energy production for the default operating mode (full reservoir) is estimated to be 48,531 MWh corresponding to an annual plant factor of 0.54. Low water year generation (2004) would be 22,929 MWh and high water year generation (1984) would be 86,260 MWh. It is estimated that power production would be reduced by about 5% under the optional operating mode where Twin Lakes elects to utilize up to 5,000 acre-ft of reservoir storage for irrigation purposes during dry years.

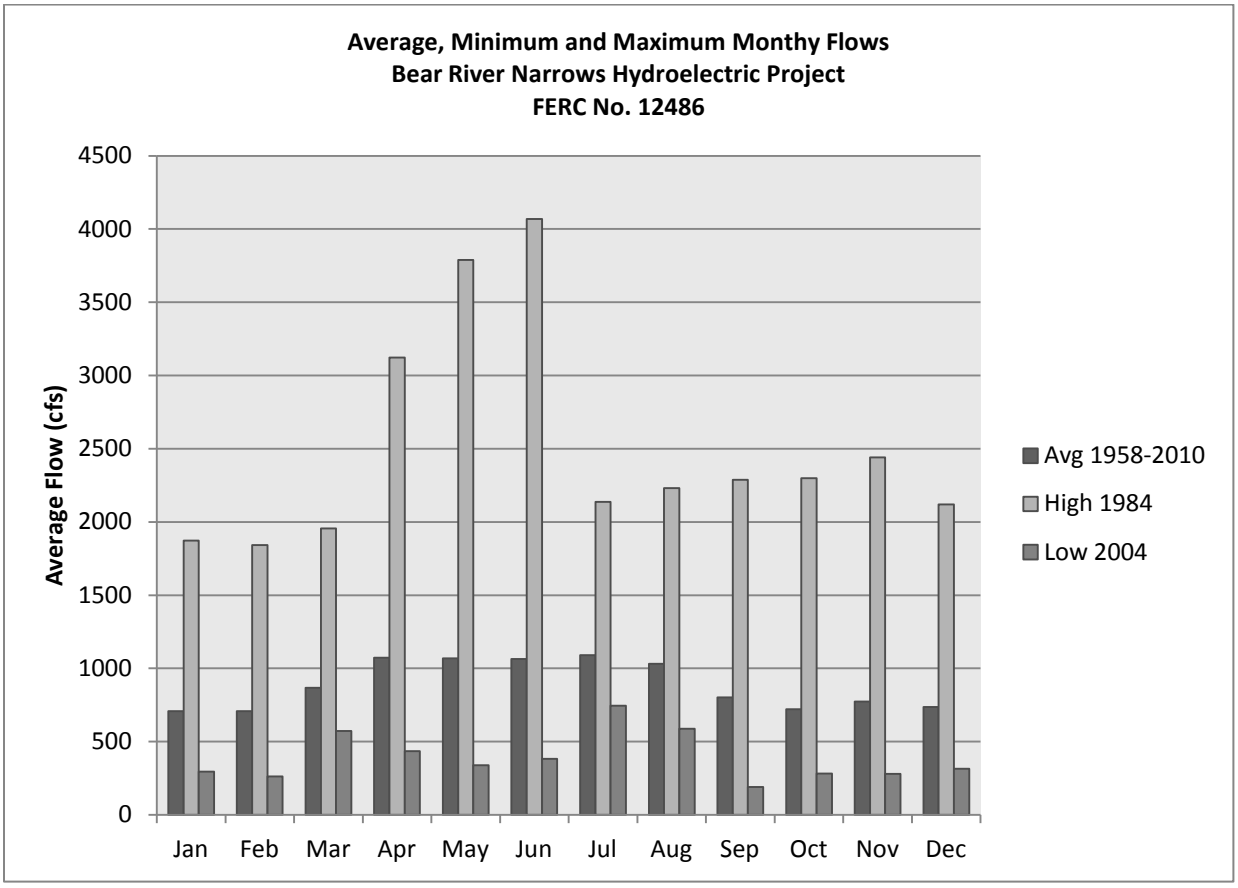


Figure B-1. Monthly releases from Oneida Reservoir, 1958 – 2010.

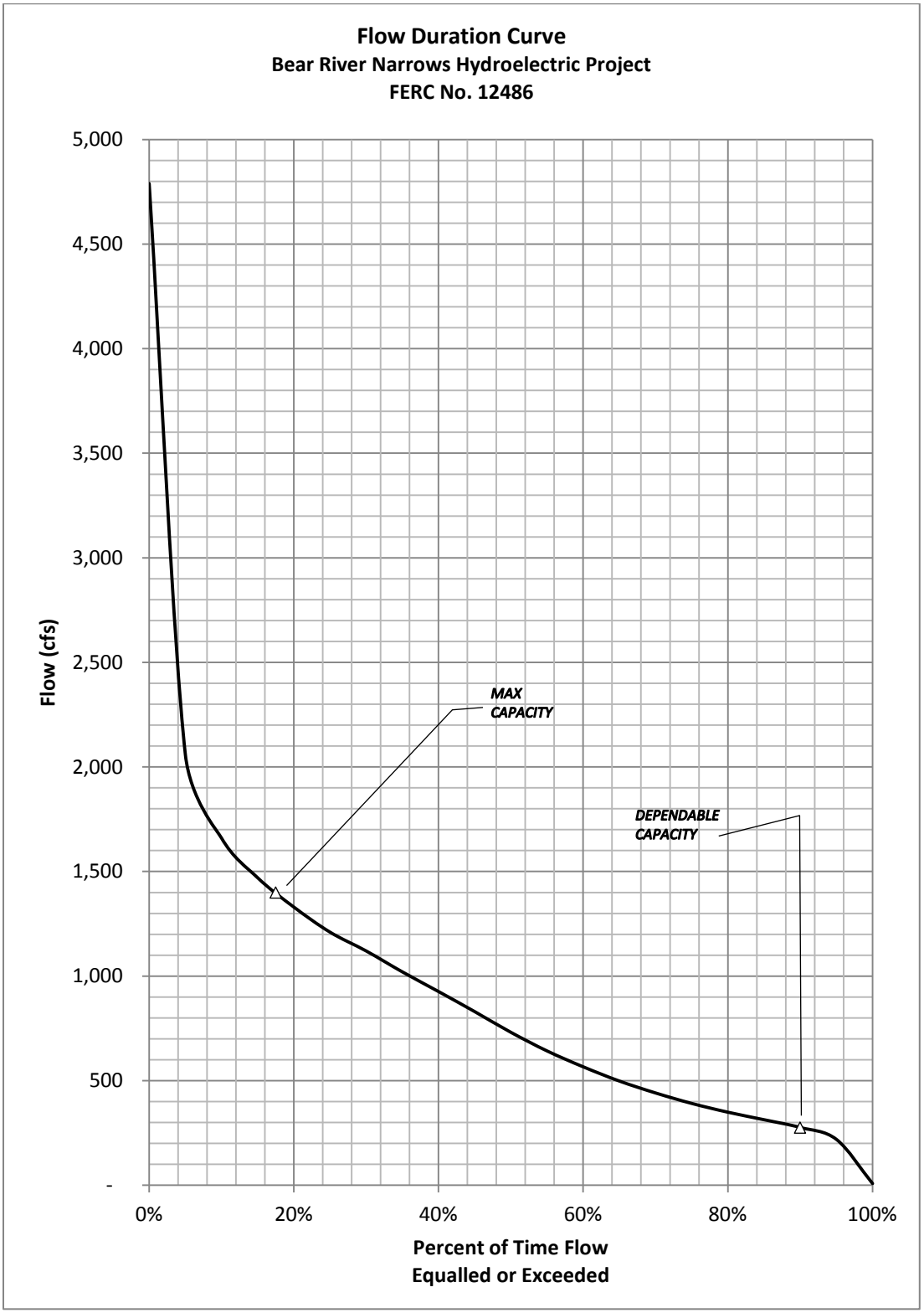


Figure B-2. Flow duration curve for releases from Oneida Reservoir, 1958 – 2010.

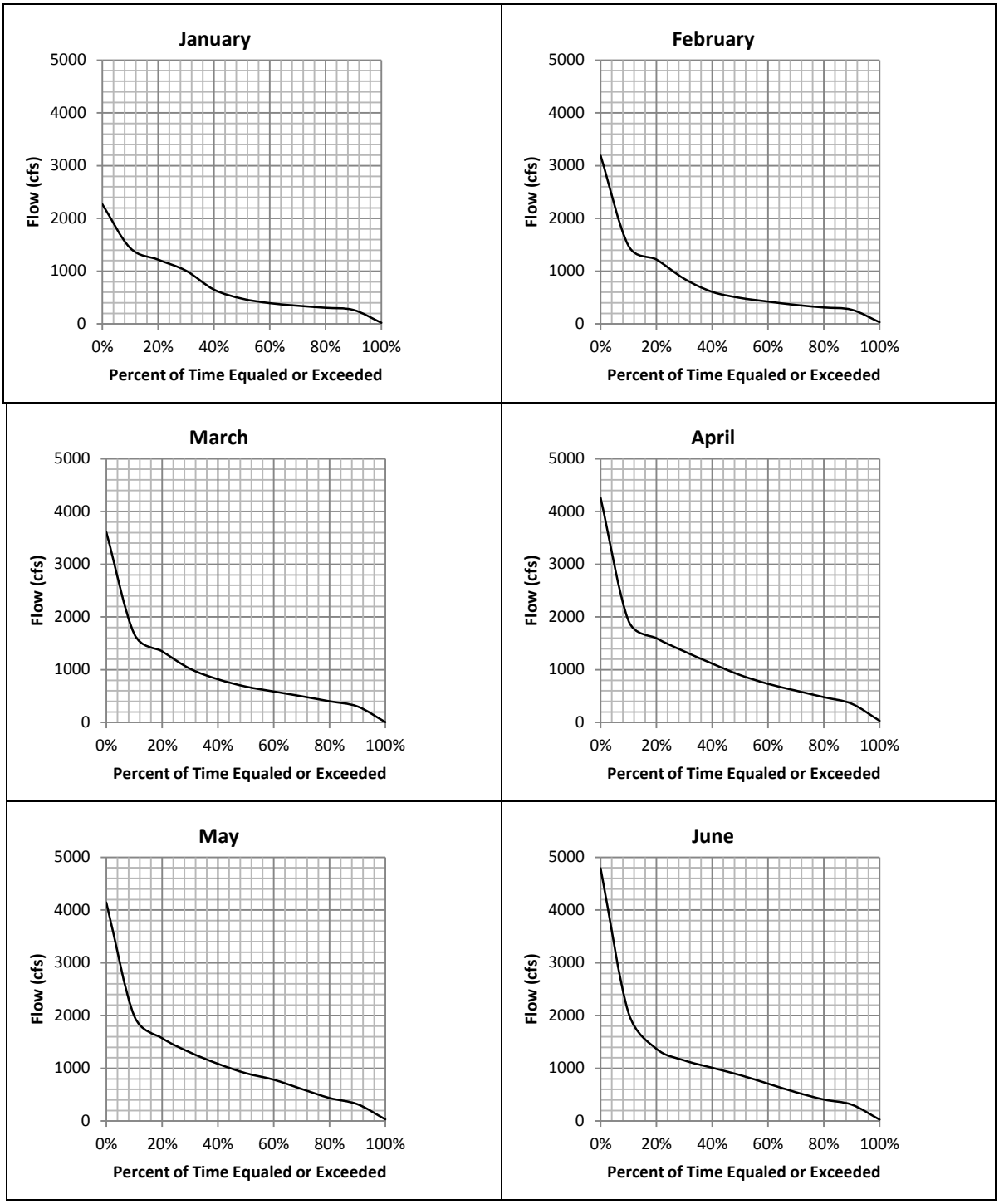


Figure B-3. Monthly flow duration curves for releases from Oneida Reservoir, 1958 – 2010, Jan - Jun.

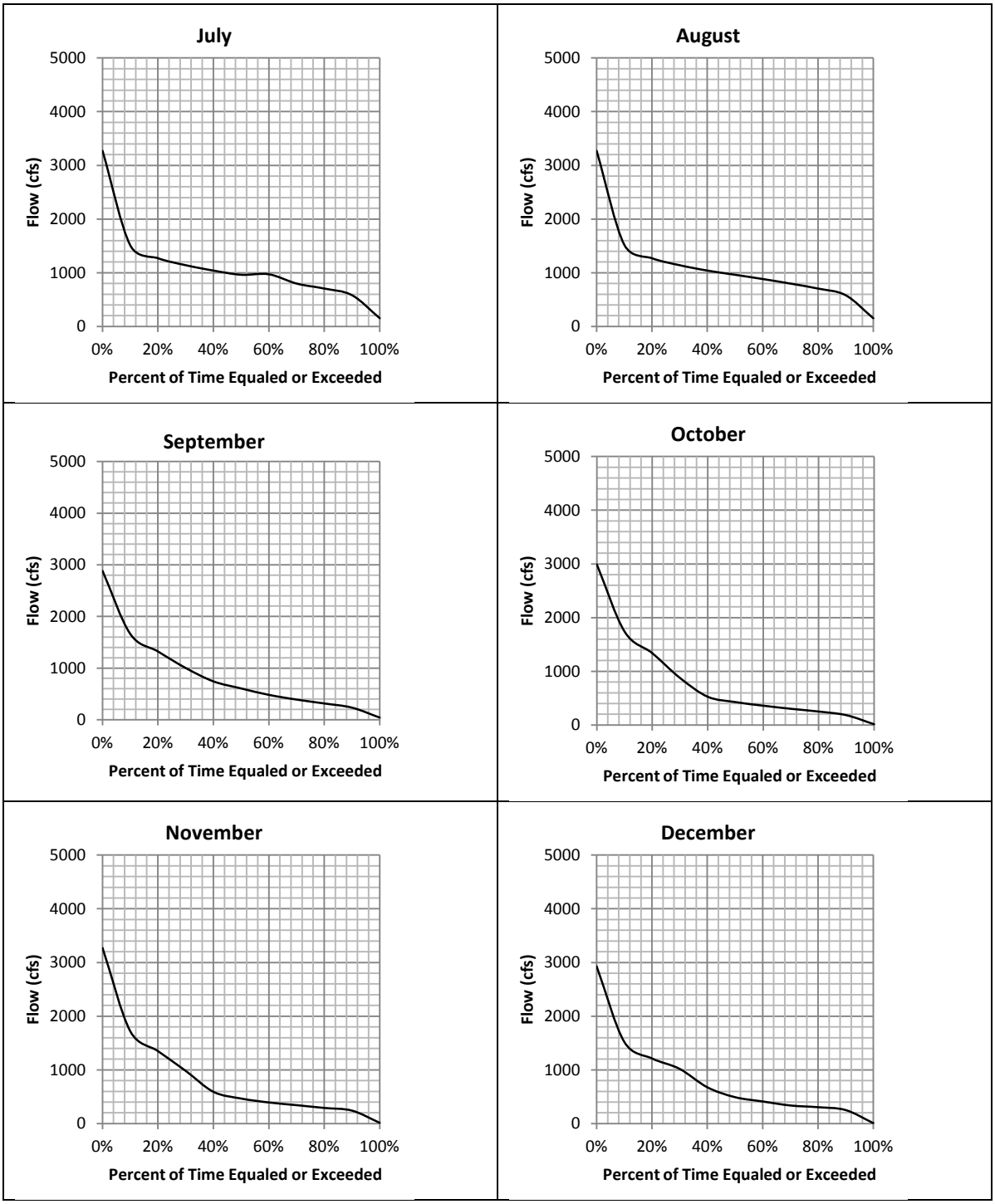


Figure B-4. Monthly flow duration curves for releases from Oneida Reservoir, 1958 – 2010, Jul - Dec.

Table B-1. Monthly flow duration statistics in cfs for releases from Oneida Reservoir, 1958 – 2010.

PERCENT OF TIME EQUALED OR EXCEEDED	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
100%	24	31	8	35	31	28	152	152	39	14	15	10
90%	267	268	305	359	323	317	583	583	233	187	242	255
80%	308	311	405	484	433	410	707	707	315	252	293	308
70%	347	359	495	600	594	550	801	801	388	304	345	343
60%	396	423	586	725	756	710	974	888	475	356	395	415
50%	482	493	678	884	896	865	967	967	601	422	463	490
40%	652	607	816	1100	1070	1000	1050	1050	730	518	581	660
30%	1010	854	1019	1333	1290	1150	1150	1150	971	847	953	1010
20%	1220	1220	1340	1580	1560	1360	1270	1270	1310	1320	1340	1210
10%	1440	1480	1680	1910	1980	2040	1509	1510	1650	1728	1710	1520
0%	2270	3190	3610	4260	4140	4790	3270	3270	2880	2990	3270	2930

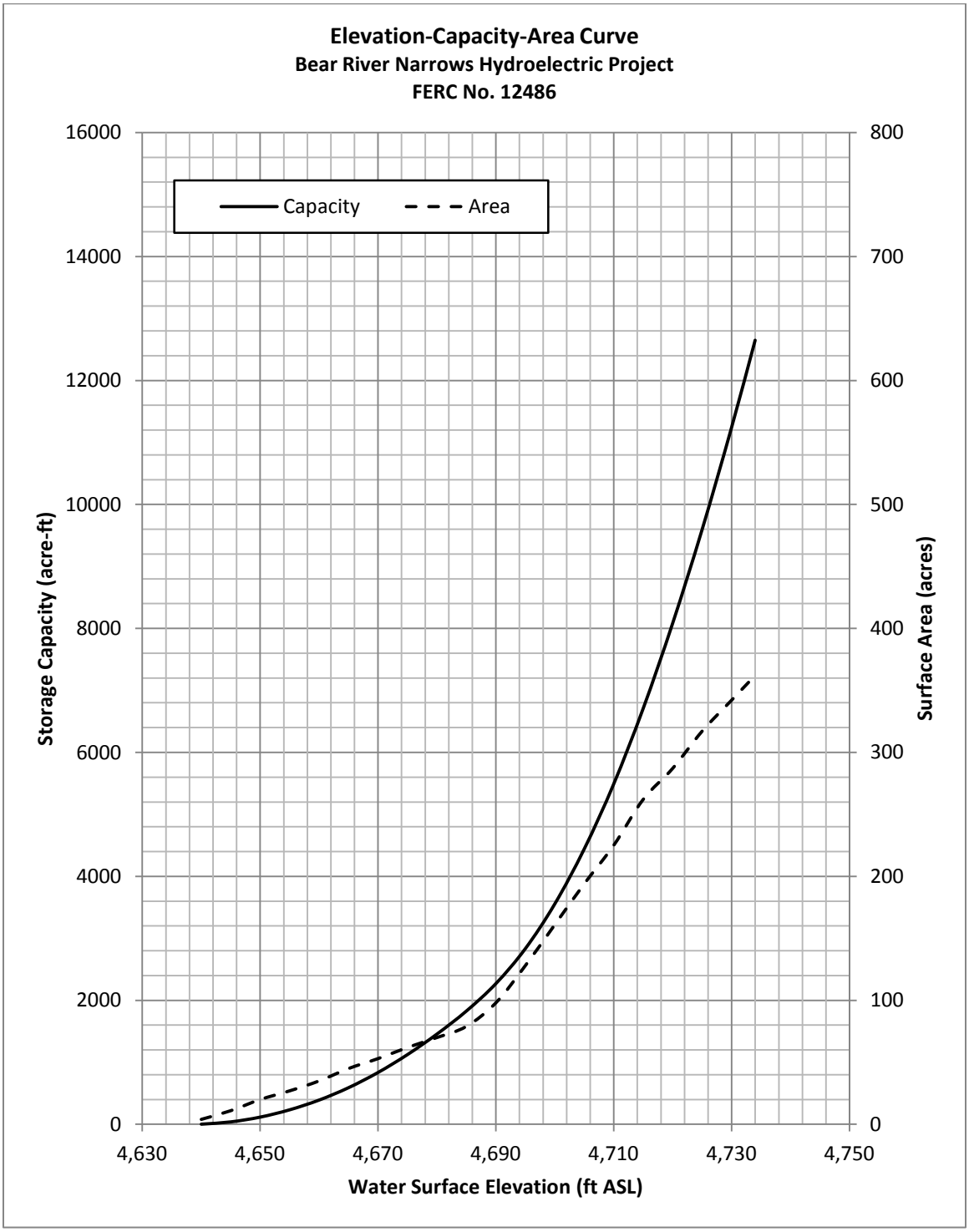


Figure B-5. Elevation-capacity-area curve for proposed Bear River Narrows Reservoir.

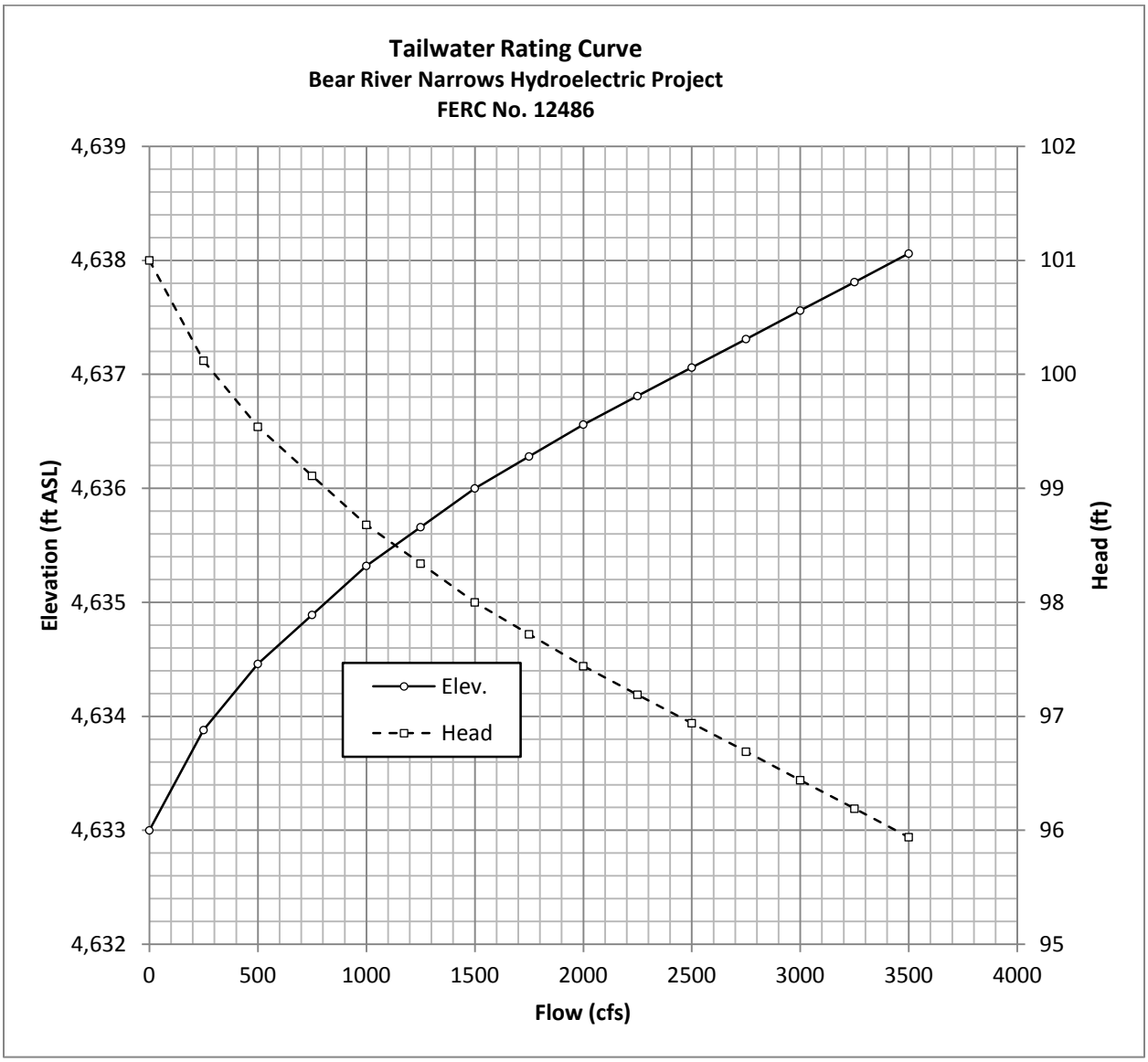


Figure B-6. Tailwater rating curve for proposed Bear River Narrows Project.

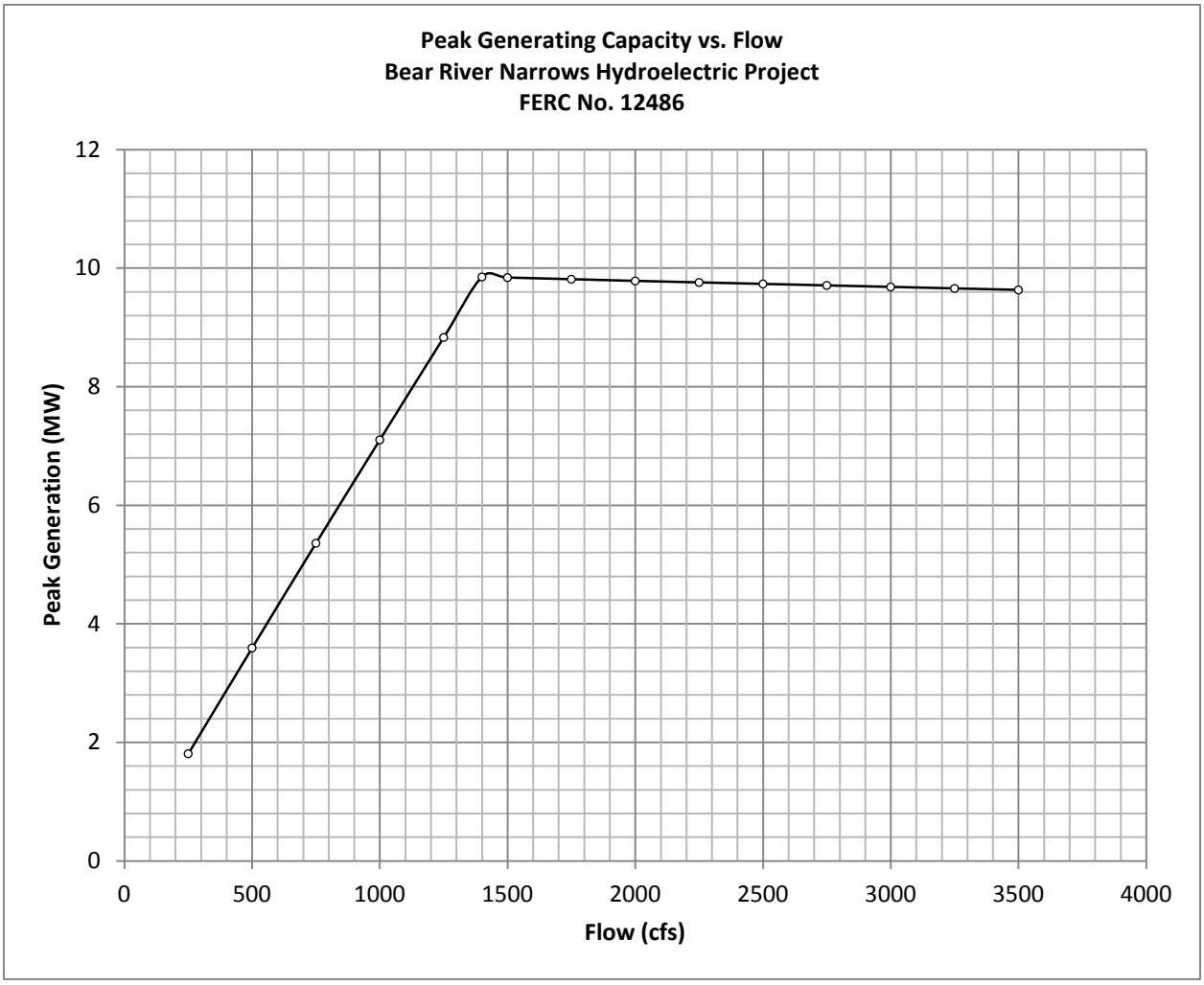


Figure B-7. Peak generating capacity for proposed Bear River Narrows Project.

2.2 Use of Project Output

The Applicant intends to sell the output from the project to PacifiCorp under the provisions of the 1978 PURPA Act. Station service, estimated at less than 1% of the total output, would be provided by the plant, with the remainder being transmitted via the proposed 46 kV transmission line to an existing PacifiCorp line. Alternatively, the project output would be sold to Idaho Power or to one of the many regional power companies actively seeking renewable energy sources.

3 Future Development

The Applicant has no plans for future additional development.

4 Summary

The major project features discussed in this Exhibit are summarized in Table 5.

Table B-2. Bear River Narrows Hydroelectric Project summary.

PROJECT ELEMENT	SPECIFICATIONS
Hydraulic Capacity	
Turbine No. 1 MIN	175 cfs
Turbine No. 1 MAX	700 cfs
Turbine No. 2 MIN	175 cfs
Turbine No. 2 MAX	700 cfs
TOTAL MAX	1,400 cfs
Maximum Head	101 ft
Minimum Head	96 ft
Normal head	98 ft
Penstock Diameter	14 ft
Penstock Length	600 ft
Installed Capacity	10.0 MW
Dependable Capacity	2.0 MW
Average Annual Power (full reservoir)	48,531 MWh
Average Annual Power (5,000 acre-ft drawdown)	46,104 MWh

WORKS CITED

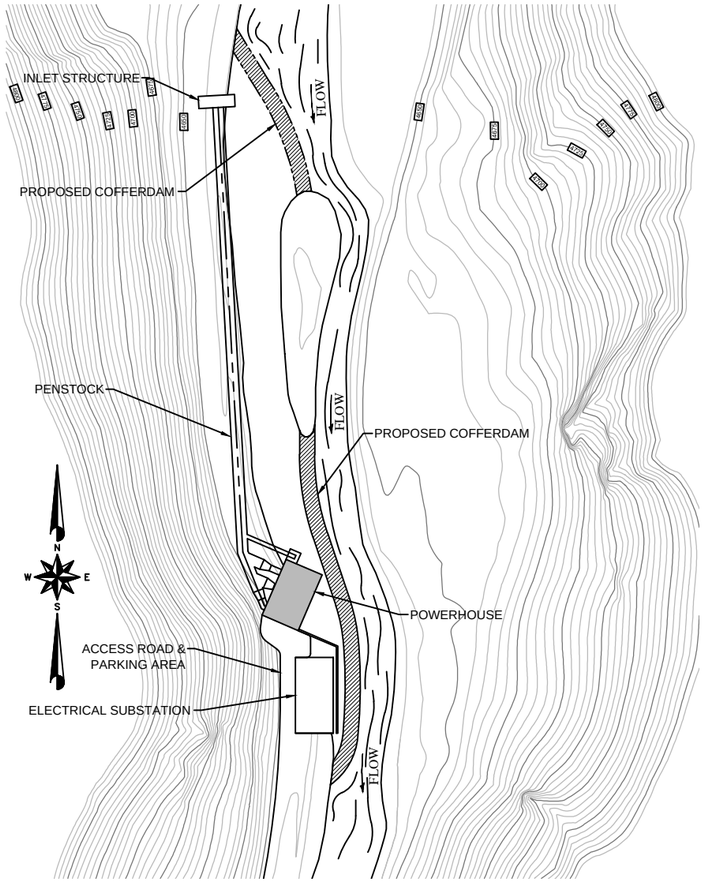
Calder, L. (1960a). *Oneida Narrows Dam Bear River Project Reconaissance Geologic Report No. G-135: Oneida Narrows Dam and Reservoir Sites.* Salt Lake City, UT: U.S. Bureau of Reclamation.

PacifiCorp. (2004). *Operations and Compliance Plan, Bear River Narrows hydroelectric Project, FERC Proejct No. 20.* Portland, OR: PacifiCorp.

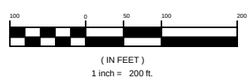
Schiess and Associates. (2009a). *Study 13 Reservoir Capacity and Evaporative Loss Study Final Report.* Preston, ID: Twin Lakes Canal Company.

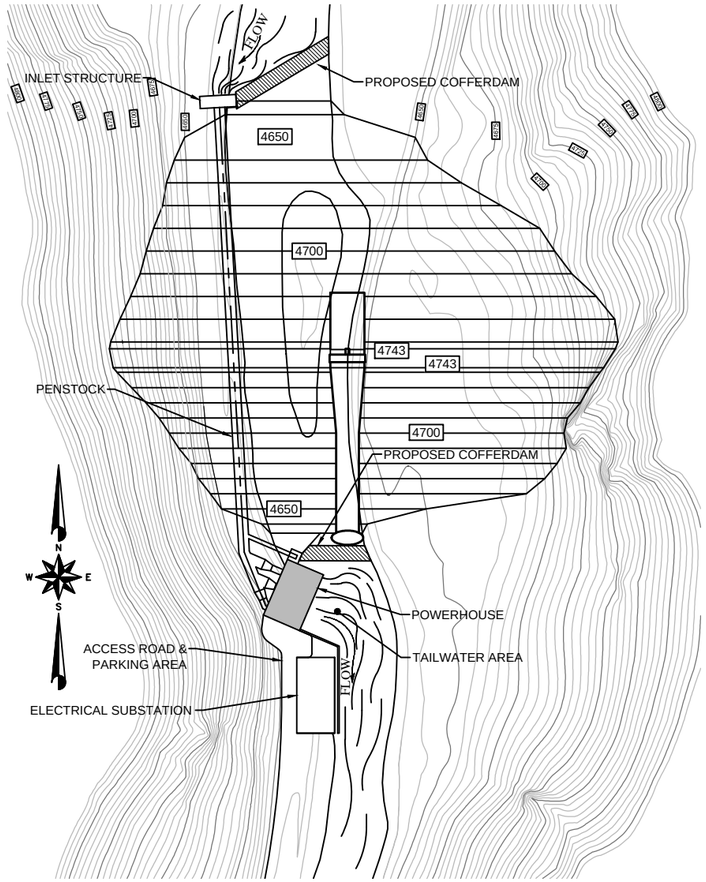
Schiess and Associates. (2009b). *Study 17 Tailwater Elevation Study Final Report.* Preston, ID: Twin Lake Canal Company.

EXHIBIT F – PRELIMINARY DESIGN DRAWINGS

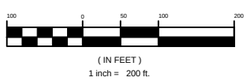


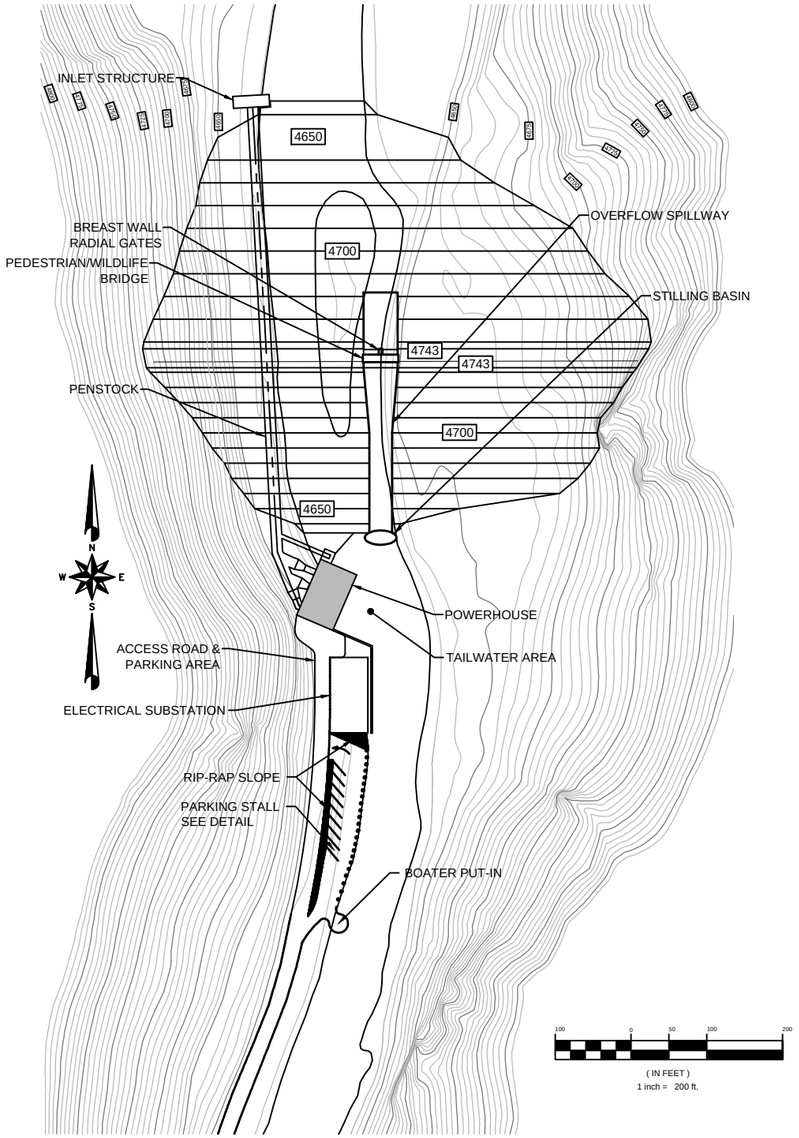
PHASE I RIVER BYPASS PLAN





PHASE II RIVER BYPASS PLAN

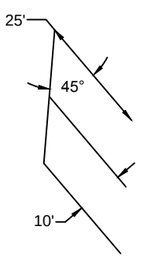




PROPOSED DAM & POWERHOUSE SITE PLAN

PARKING STALL DETAIL

N.T.S.



BEAR RIVER NARROWS
HYDROELECTRIC PROJECT
RIVER BY-PASS AND SITE PLANS
FERC NO. 12486
EXHIBIT F-1

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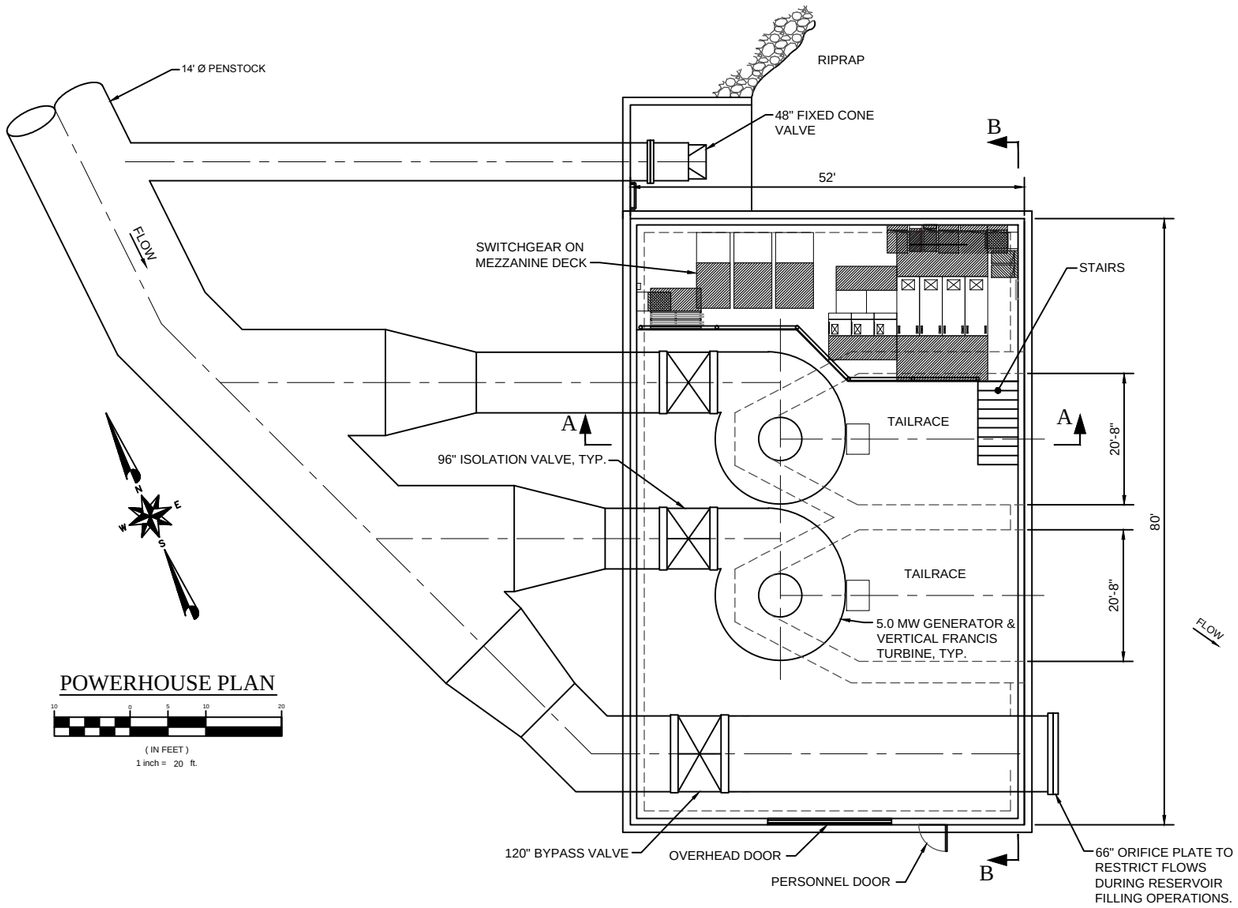
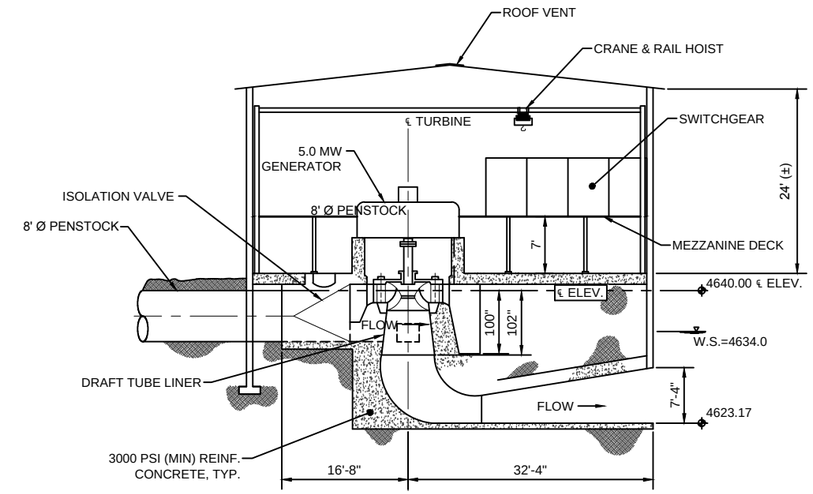


POWERHOUSE PLAN

(IN FEET)
1 inch = 20 ft.



ELEVATION SECTION A-A

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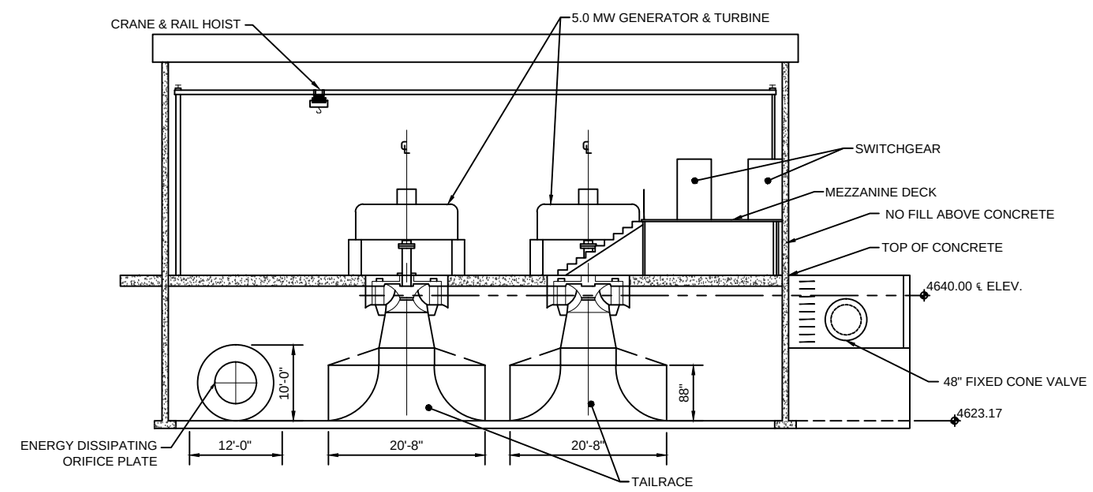

ELEVATION SECTION B-B

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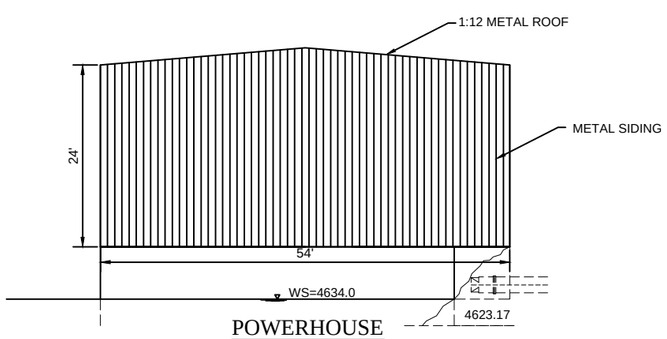

POWERHOUSE NORTH ELEVATION

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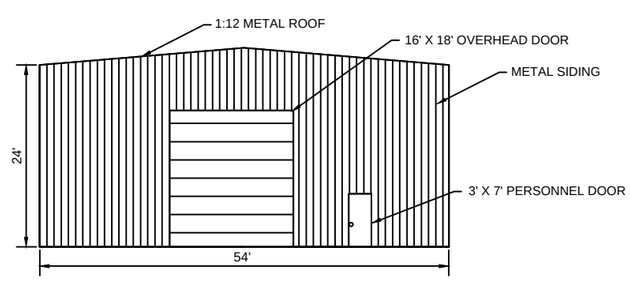

POWERHOUSE SOUTH ELEVATION

(IN FEET)
1 inch = 20 ft.

BEAR RIVER NARROWS
HYDROELECTRIC PROJECT
POWERHOUSE PLAN & SECTIONS
FERC NO. 12486

EXHIBIT F-2

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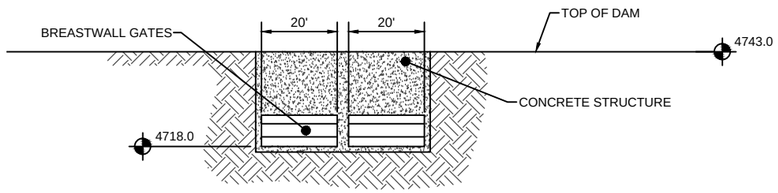
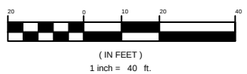
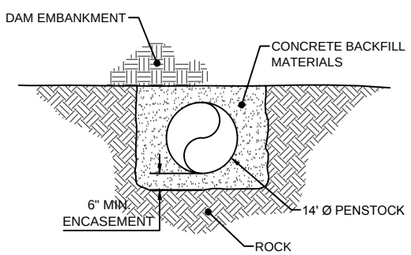


SECTION A-A

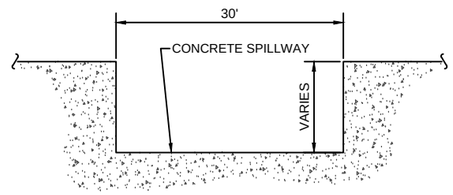
SCALE: 1"=40'





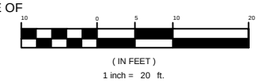
DETAIL PENSTOCK TRENCH

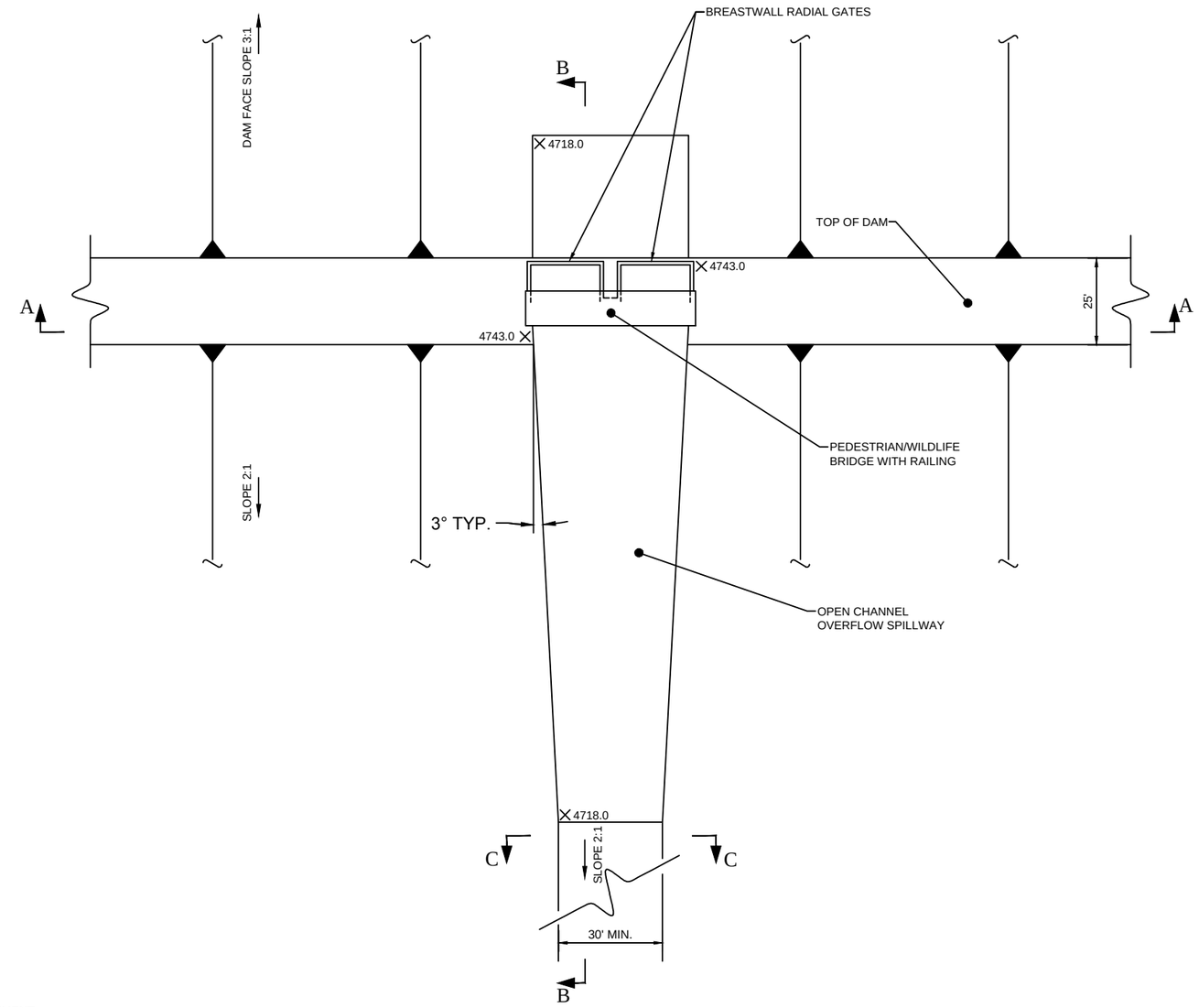
SCALE: N.T.S.



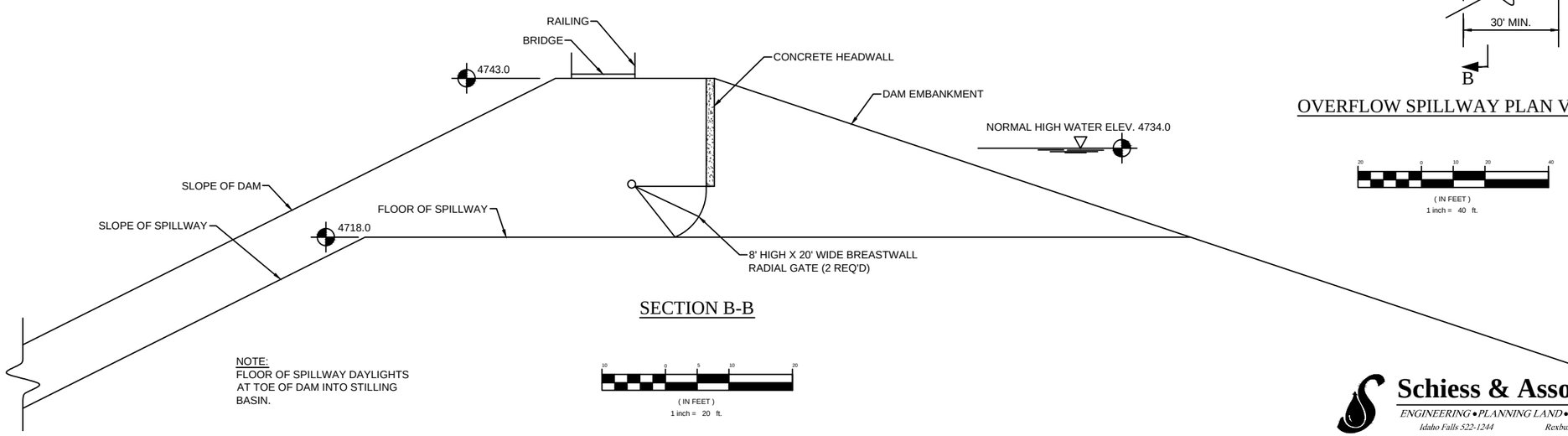
SECTION C-C

NOTE:
SPILLWAY SHALL BE ROLLER COMPACTED CONCRETE VALLEY THROUGH DAM SURFACE OF SAME MATERIAL.





OVERFLOW SPILLWAY PLAN VIEW



SECTION B-B

NOTE:
FLOOR OF SPILLWAY DAYLIGHTS AT TOE OF DAM INTO STILLING BASIN.

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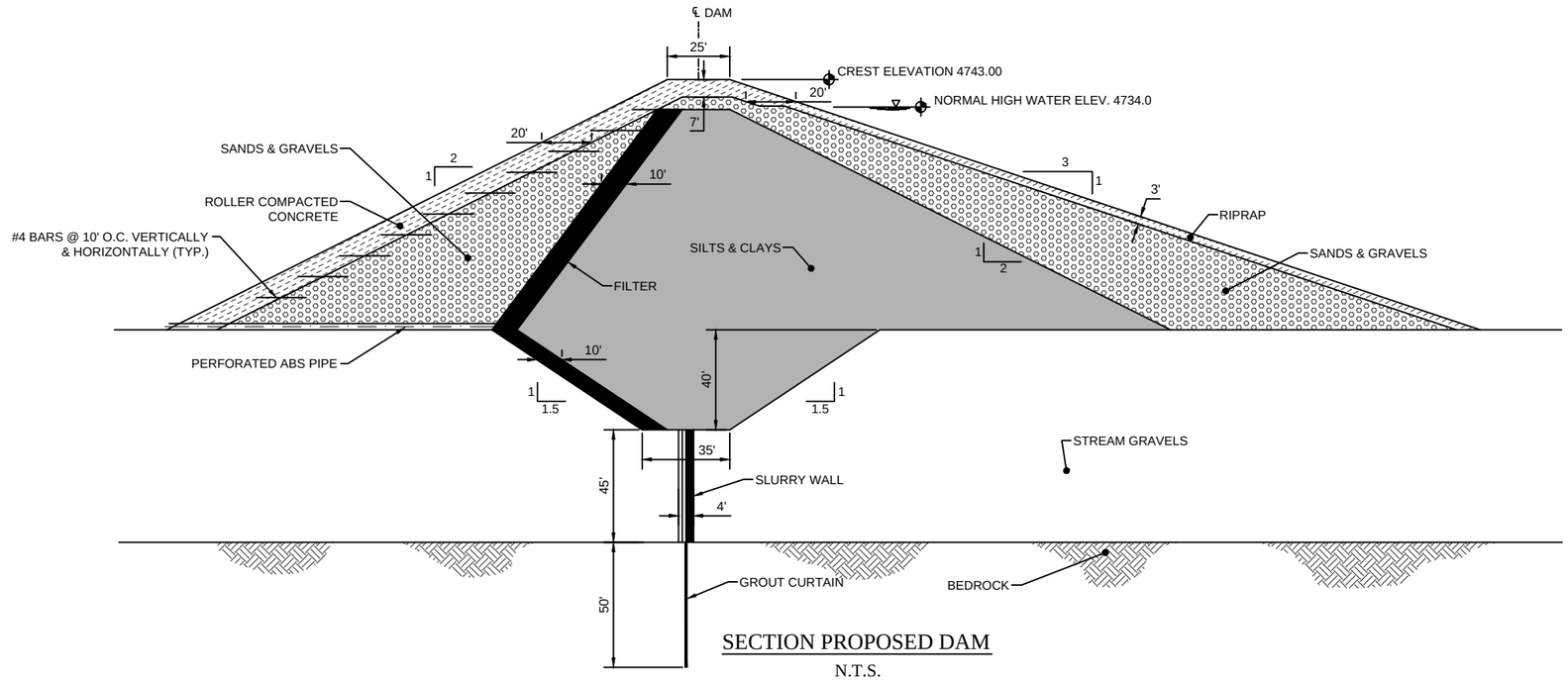
BEAR RIVER NARROWS
HYDROELECTRIC PROJECT
PENSTOCK & SPILLWAY DETAILS
FERC NO. 12486
EXHIBIT F-3



SECTION PROPOSED DAM

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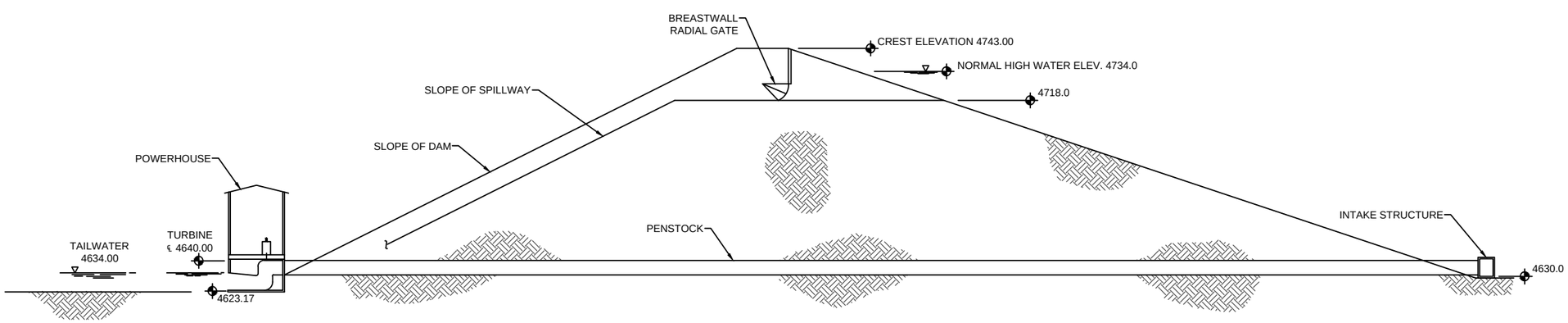

HYDRAULIC PROFILE

N.T.S.

BEAR RIVER NARROWS
HYDROELECTRIC PROJECT
PROPOSED DAM SECTION
& HYDRAULIC PROFILE

FERC NO. 12486 EXHIBIT F-4

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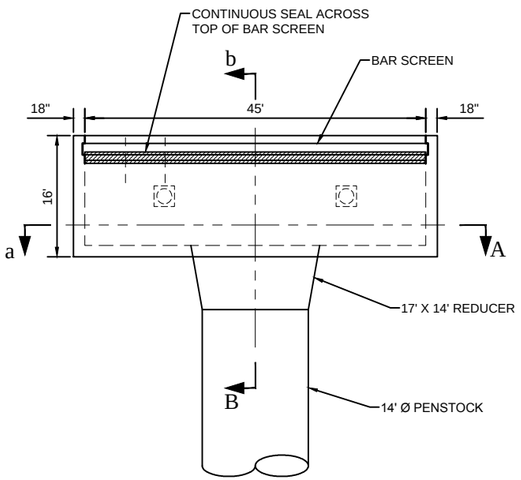
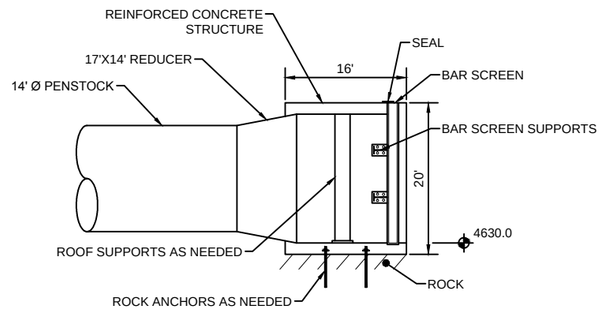


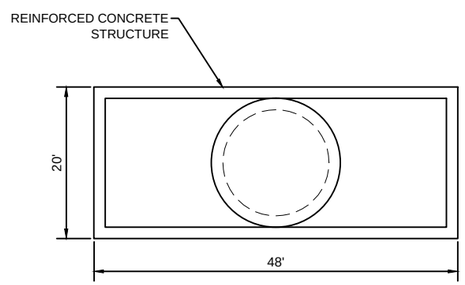
INTAKE STRUCTURE PLAN VIEW

(IN FEET)
1 inch = 20 ft.



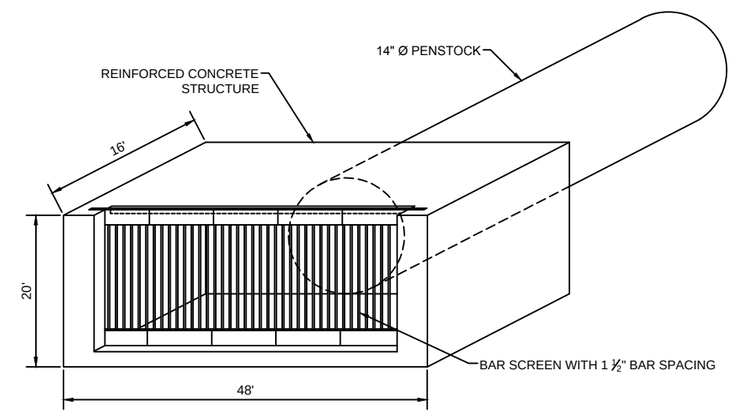
INTAKE SECTION B-b

(IN FEET)
1 inch = 20 ft.



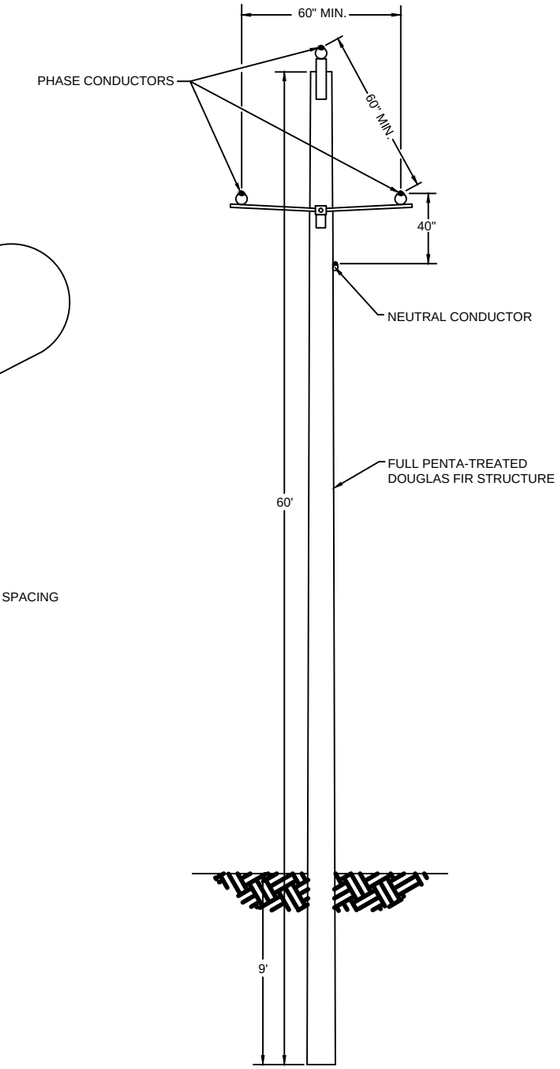
INTAKE SECTION A-a

(IN FEET)
1 inch = 20 ft.

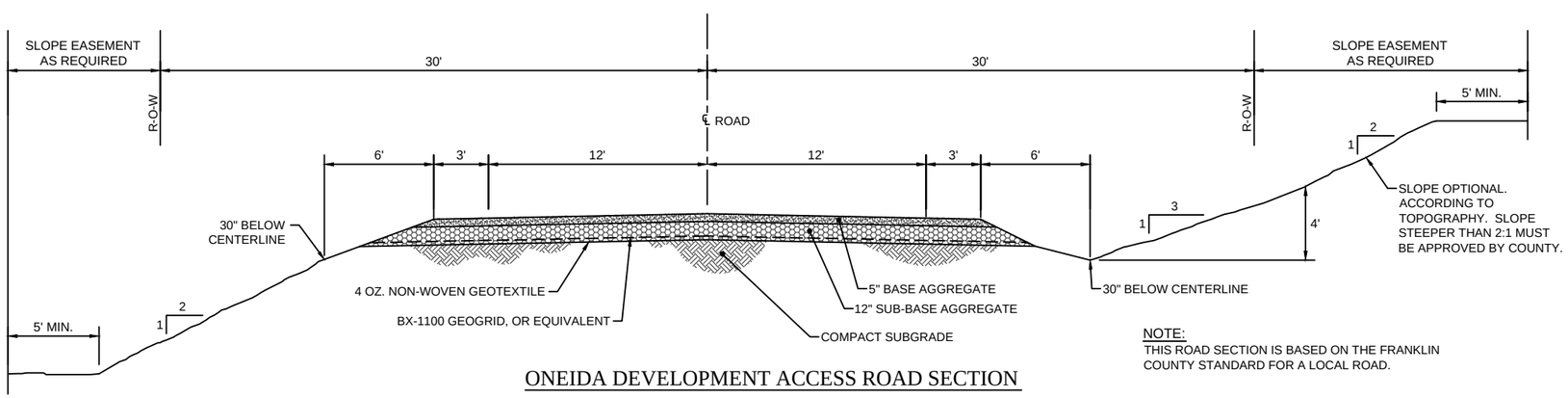


ISOMETRIC VIEW

(IN FEET)
1 inch = 20 ft.



46 kV TRANSMISSION LINE STRUCTURE (TYPICAL)
N.T.S.



ONEIDA DEVELOPMENT ACCESS ROAD SECTION

(IN FEET)
1 inch = 8 ft.

NOTE:
THIS ROAD SECTION IS BASED ON THE FRANKLIN COUNTY STANDARD FOR A LOCAL ROAD.

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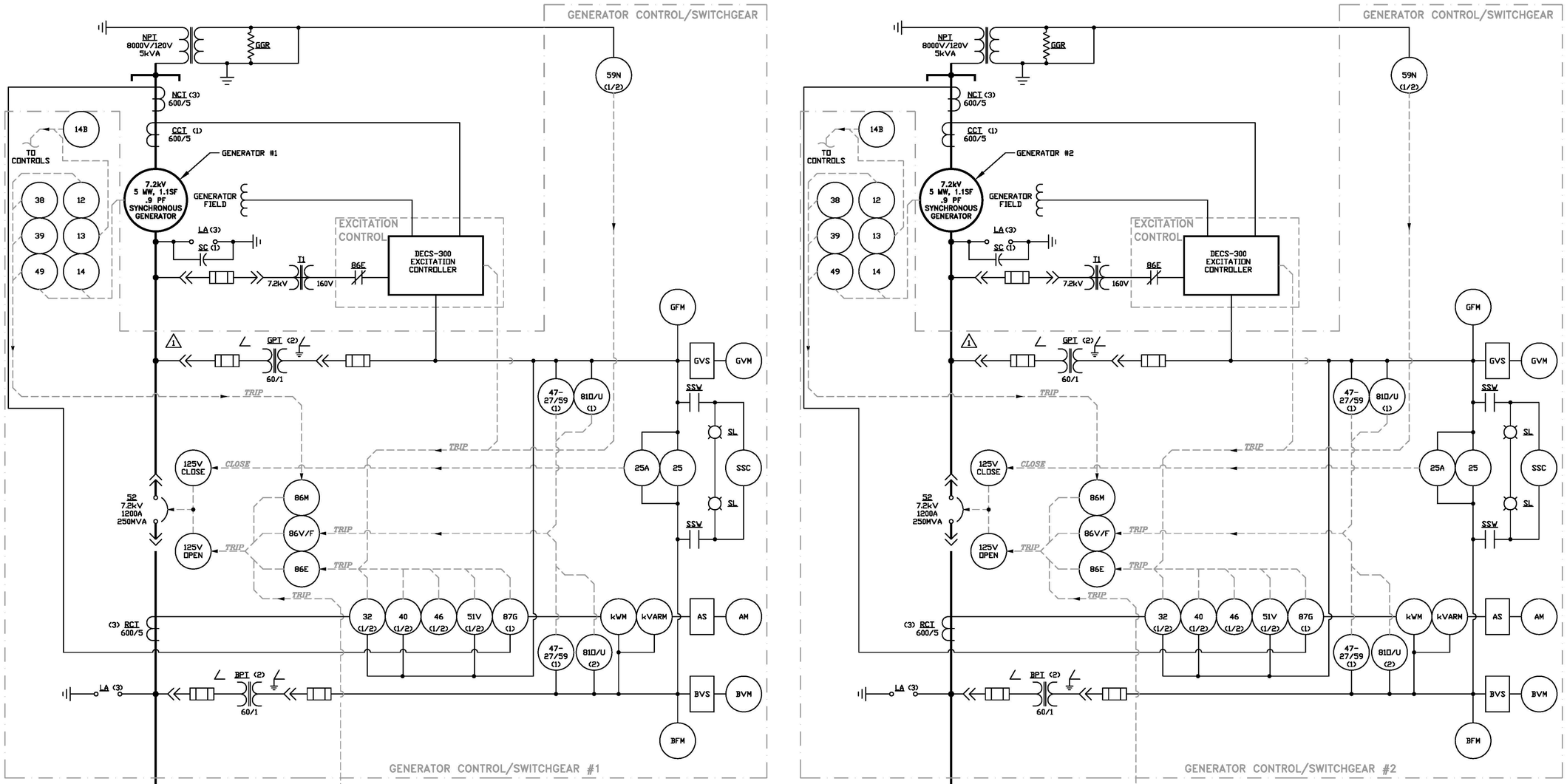
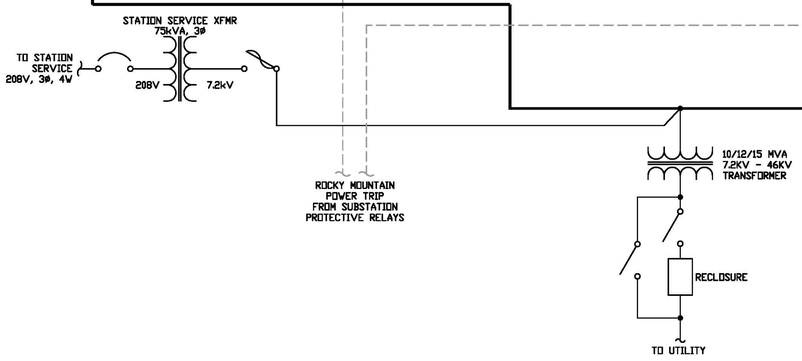
BEAR RIVER NARROWS
HYDROELECTRIC PROJECT
INTAKE STRUCTURE DETAILS
& ROAD SECTION

FERC NO. 12486 EXHIBIT F-5





DEVICE LEGEND

12	- OVERSPEED RELAY	BFM	- BUS FREQUENCY METER
13	- SYNC SPEED RELAY	BPT	- BUS POTENTIAL TRANSFORMER
14	- UNDERPSEED RELAY	BVM	- BUS VOLTMETER
14B	- SECONDARY UNDERSPEED RELAY	BVS	- BUS VOLTMETER SWITCH
25	- SYNC CHECK RELAY	CCT	- CROSS CURRENT TRANSFORMER
25A	- AUTO SYNCHRONIZER	GFM	- GENERATOR FREQUENCY METER
32	- REVERSE POWER RELAY	GPT	- GENERATOR POTENTIAL TRANSFORMER
38	- BEARING OVER TEMPERATURE	GGR	- GEN GROUNDING RESISTOR
39	- OVER VIBRATION	GVM	- GENERATOR VOLTMETER
40	- LOSS OF EXCITATION	GVS	- GENERATOR VOLTMETER SWITCH
46	- PHASE BALANCE RELAY	kVARM	- KILOVAR METER
47-27/59	- PHASE SEQ-UNDER/OVER VOLTAGE RELAY	kWM	- KILOWATT METER
49	- OVER TEMPERATURE RELAY	LA	- LIGHTNING ARRESTOR
51V	- VOLT RESTRAINED OVERCURRENT RELAY	NCT	- NEUTRAL CURRENT TRANSFORMER
52	- MAIN CIRCUIT BREAKER	NPT	- NEUTRAL POTENTIAL TRANSFORMER
59N	- NEUTRAL OVERVOLTAGE RELAY	RCT	- RELAYING CURRENT TRANSFORMER
81O/U	- OVER/UNDER FREQUENCY RELAY	SC	- SURGE CAPACITOR
86E	- ELECTRICAL LOCKOUT RELAY	SL	- SYNC LIGHT
86M	- MECHANICAL LOCKOUT RELAY	SSC	- SYNCSCOPE
86V/F	- VOLT/FREQ LOCKOUT RELAY	SSW	- SYNC SWITCH
87G	- GENERATOR DIFFERENTIAL RELAY	TDCT	- TRANSFORMER DIFFERENTIAL CURRENT TRANSFORMER
AM	- AMMETER	T1	- EXCITATION TRANSFORMER
AS	- AMMETER SWITCH		

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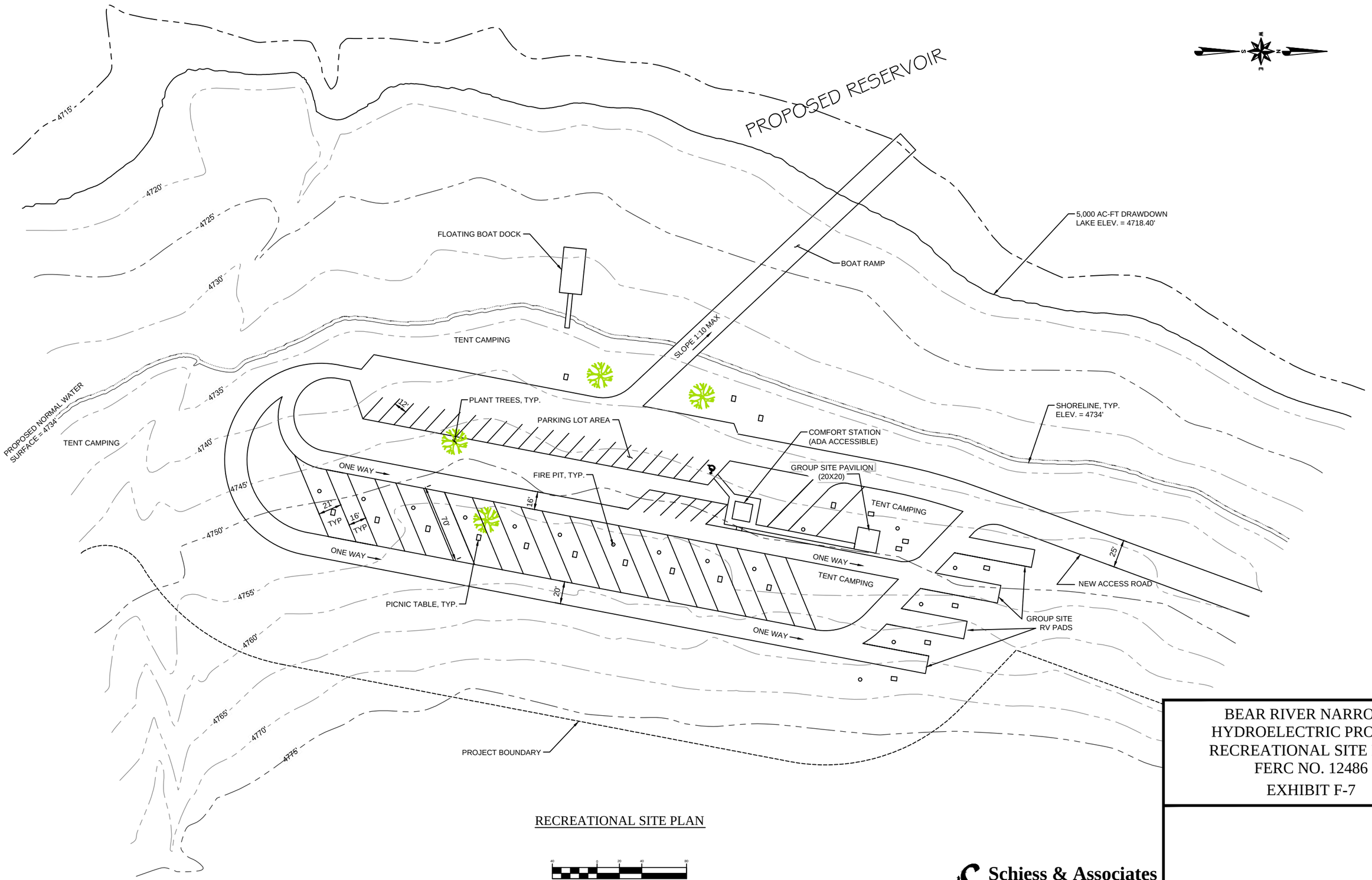
BEAR RIVER NARROWS HYDROELECTRIC PROJECT
ONE-LINE DIAGRAM
FERC NO. 12486
EXHIBIT F-6



RECREATIONAL SITE PLAN

(IN FEET)
1 inch = 80 ft.

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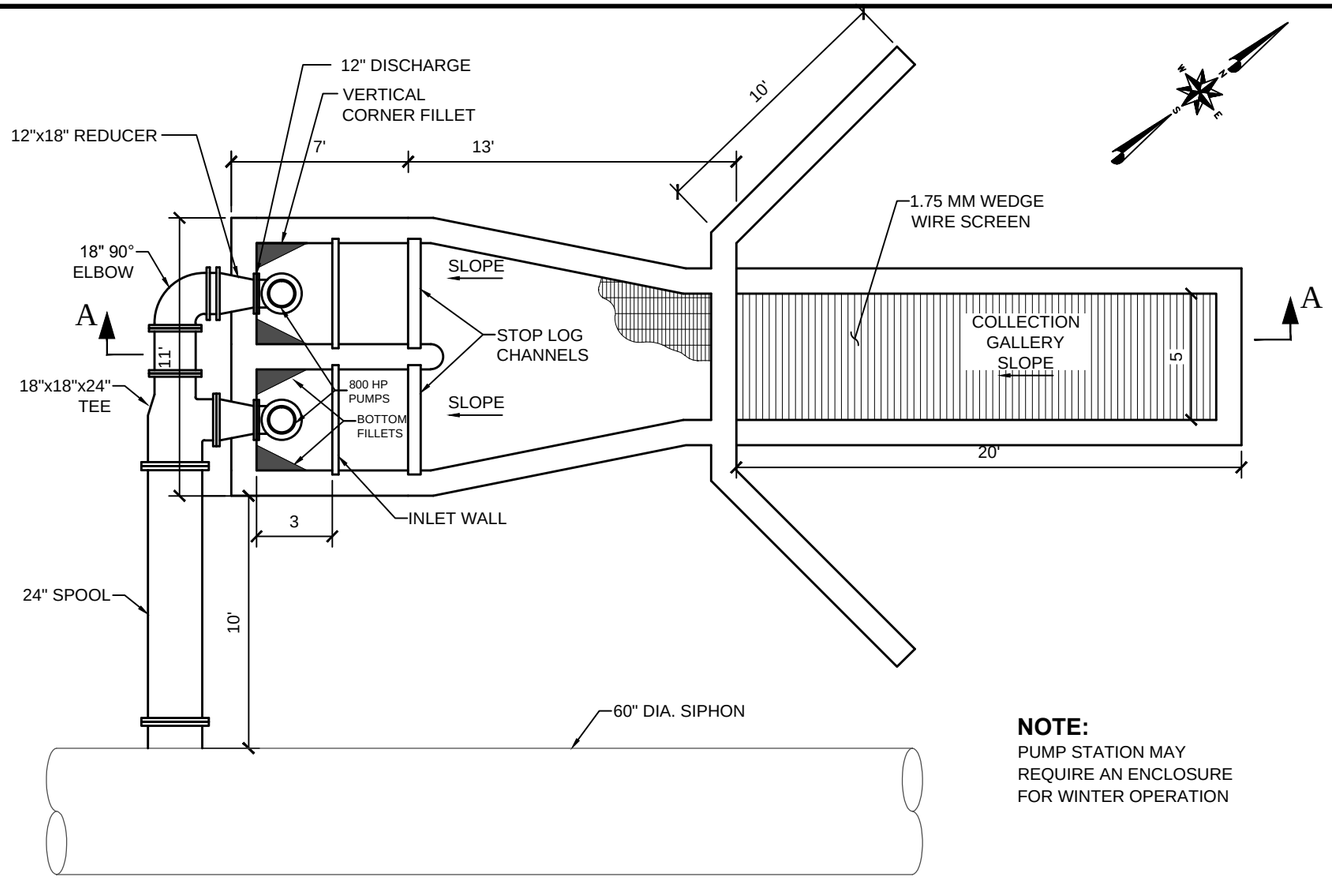
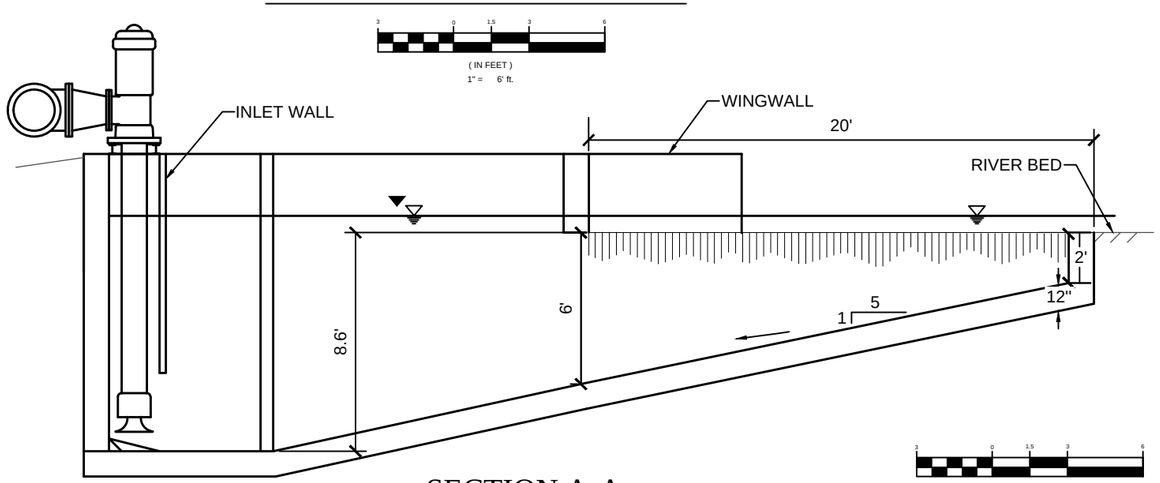
BEAR RIVER NARROWS
HYDROELECTRIC PROJECT
RECREATIONAL SITE PLAN
FERC NO. 12486
EXHIBIT F-7

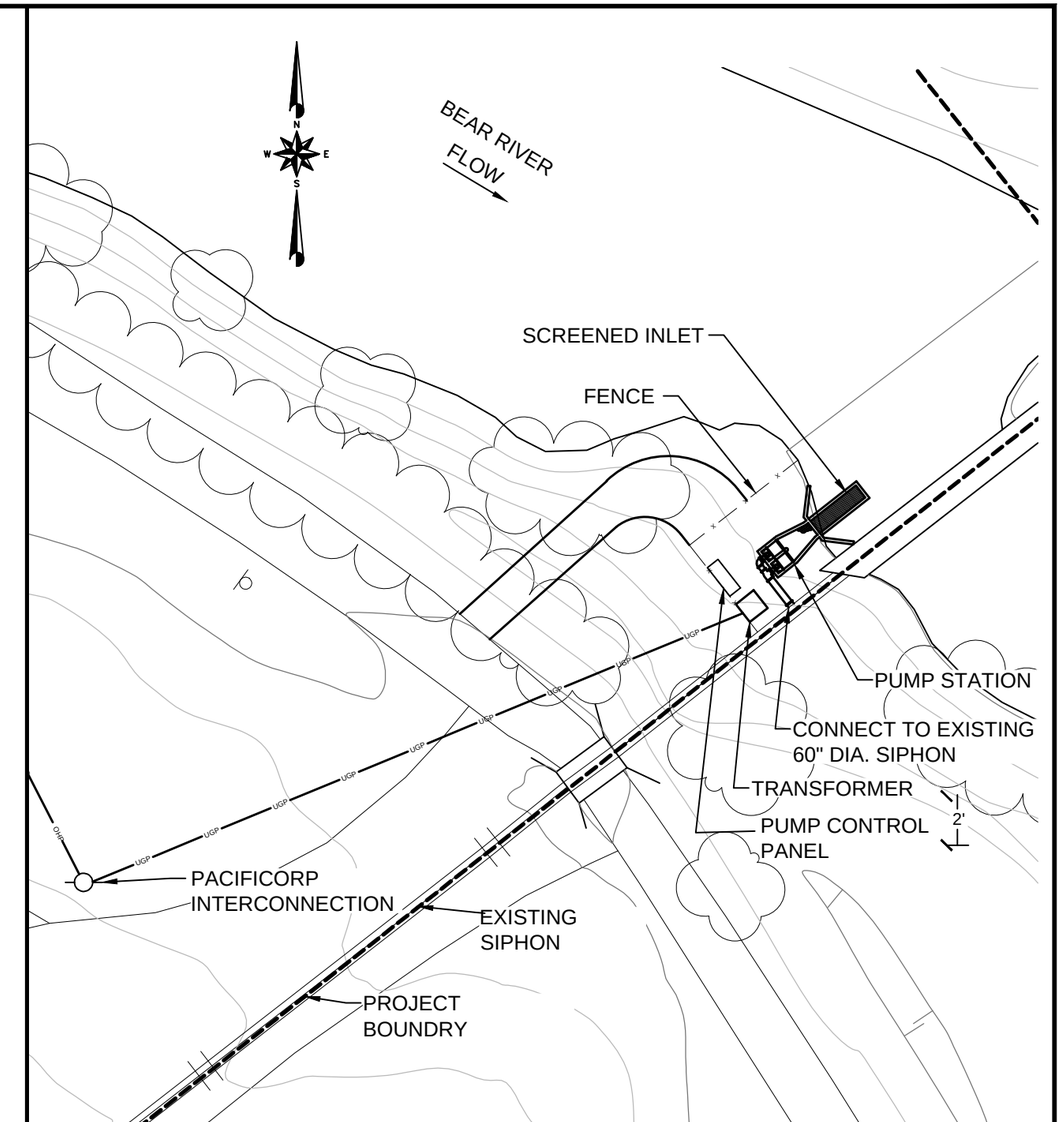


NOTE:
PUMP STATION MAY REQUIRE AN ENCLOSURE FOR WINTER OPERATION

BEAR RIVER PUMP STATION



SECTION A-A



PUMP STATION PLAN VIEW

(IN FEET)
1 inch = 50 ft.

BEAR RIVER NARROWS
HYDROELECTRIC PROJECT
PUMP STATION
FERC NO. 12486
EXHIBIT F-8

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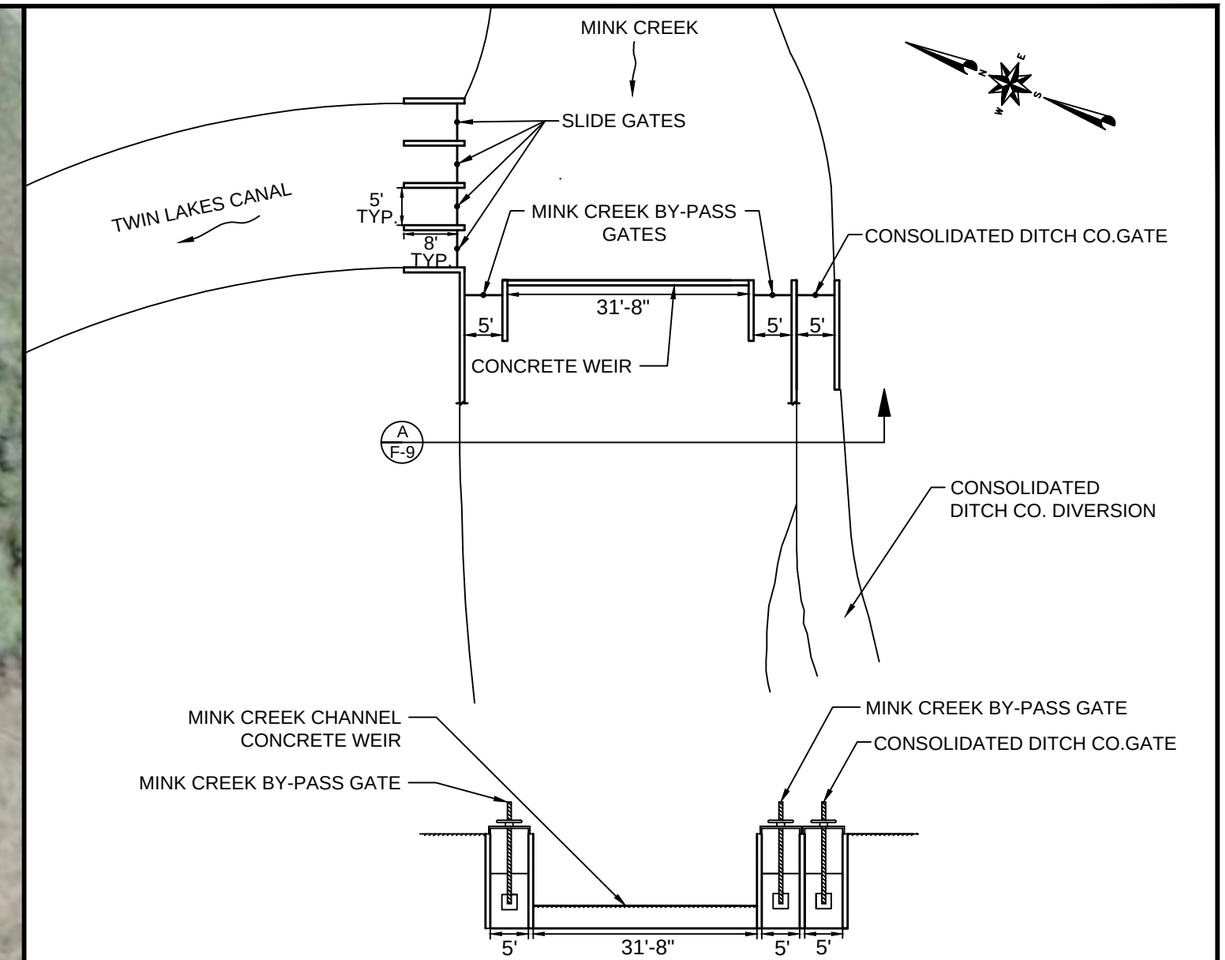

A F-9 **MINK CREEK DIVERSION WEST ELEVATION**

TWIN LAKES CANAL - MINK CREEK DIVERSION

NOTE:
AN AUTOMATED GAGING STATION WILL BE INSTALLED IN MINK CREEK. IN A LOCATION THAT WILL BE SELECTED DOWN STREAM OF THE TWIN LAKES DIVERSION.

10 0 5 10 20
(IN FEET)
1 inch = 20 ft.

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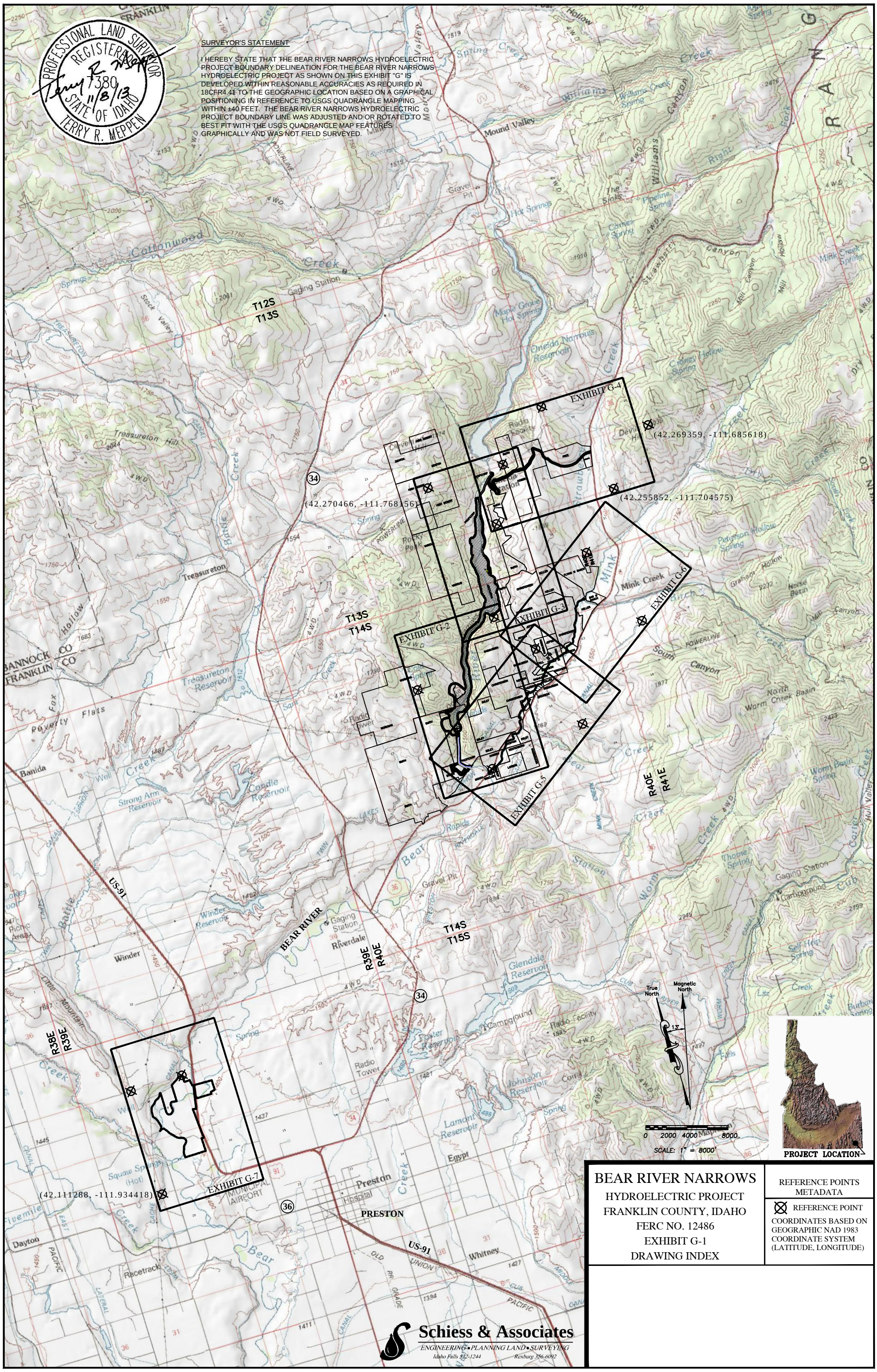
BEAR RIVER NARROWS
HYDROELECTRIC PROJECT
MINK CREEK DIVERSION
FERC NO. 12486
EXHIBIT F-9

EXHIBIT G – PROJECT BOUNDARY DRAWINGS

PROFESSIONAL LAND SURVEYOR
REGISTERED
Terry R. Meppen 7380
11/8/13
STATE OF IDAHO
TERRY R. MEPPEN

SURVEYOR'S STATEMENT

I HEREBY STATE THAT THE BEAR RIVER NARROWS HYDROELECTRIC PROJECT BOUNDARY DELINEATION FOR THE BEAR RIVER NARROWS HYDROELECTRIC PROJECT AS SHOWN ON THIS EXHIBIT "G" IS DEVELOPED WITHIN REASONABLE ACCURACIES AS REQUIRED IN 18CFR4.41 TO THE GEOGRAPHIC LOCATION BASED ON A GRAPHICAL POSITIONING IN REFERENCE TO USGS QUADRANGLE MAPPING WITHIN ±40 FEET. THE BEAR RIVER NARROWS HYDROELECTRIC PROJECT BOUNDARY LINE WAS ADJUSTED AND OR ROTATED TO BEST FIT WITH THE USGS QUADRANGLE MAP FEATURES GRAPHICALLY AND WAS NOT FIELD SURVEYED.



BEAR RIVER NARROWS

HYDROELECTRIC PROJECT
FRANKLIN COUNTY, IDAHO
FERC NO. 12486
EXHIBIT G-1
DRAWING INDEX

REFERENCE POINTS METADATA

REFERENCE POINT
COORDINATES BASED ON GEOGRAPHIC NAD 1983 COORDINATE SYSTEM (LATITUDE, LONGITUDE)

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Idaho Falls 522-1244 *Rexburg 356-6092*

PROFESSIONAL LAND SURVEYOR
REGISTERED
Terry R. Meppen
11/8/13
STATE OF IDAHO
TERRY R. MEPPEN

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TRUE NORTH
MAGNETIC NORTH
13°

0 250 500 1000
SCALE: 1" = 1000'

(42.232294, -111.759083)

(42.227050, -111.787344)

MILE 3.0

PROJECT BOUNDARY

RASMUSSEN

RESERVOIR MAXIMUM POOL
ELEV=4734.0'

100' SHORELINE
BUFFER (TYPICAL)

EXISTING
SUMMER HOME
ACCESS ROAD

33.2
ACRES

BLM

CHRISTENSEN

MILE
2.0

BORROW SOURCES

PACIFICORP

EGLEY

BLM

SMITH

CHRISTENSEN

NEW SUMMER HOME
ACCESS ROAD

24.6
ACRES

PENSTOCK

DAM WITH SPILLWAY

POWER HOUSE

NEW SUBSTATION

BOATER PUT-IN

100' BUFFER FROM
CENTERLINE OF
TRANSMISSION LINE
TYPICAL BOTH SIDES

MILE
1.0

EGLEY

EXISTING ACCESS ROAD

NEW POWER TRANSMISSION LINE

EGLEY

STAGING AREA

PACIFICORP

HANSEN

NEW PUMP STATION
AT SIPHON

BOSEN

PACIFICORP INTERCONNECT
(42.193660, -111.776678)

(MINK CREEK MILE
CONFLUENCE 0.0
W/ BEAR RIVER)

MCKAY

SINCLAIR

JENSEN

TWIN LAKES
CANAL

EXISTING PACIFICORP 46
kV DISTRIBUTION LINE

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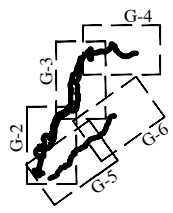

SHEET LOCATION

BEAR RIVER NARROWS
HYDROELECTRIC PROJECT
FRANKLIN COUNTY, IDAHO
FERC NO. 12486
EXHIBIT G-2
DAM & RESERVOIR

REFERENCE POINTS METADATA

REFERENCE POINT

COORDINATES BASED ON GEOGRAPHIC NAD 1983 COORDINATE SYSTEM (LATITUDE, LONGITUDE)

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PROFESSIONAL LAND SURVEYOR REGISTERED 7380 STATE OF IDAHO TERRY R. MEPPEN 11/8/13

(42.270466, -111.768156)

(42.270530, -111.739637)

ACCESS ROAD
PROJECT BOUNDARY

NEW ACCESS ROAD

EXISTING ACCESS ROAD

NEW ACCESS ROAD

(42.255787, -111.749100)

EXISTING ACCESS ROAD

NEW ACCESS ROAD

100' SHORELINE BUFFER (TYPICAL)

NEW RECREATION SITE AND BOAT RAMP

RED POINT CAMPGROUND TO BE INUNDATED

(42.232294, -111.759083)

MILE 6.4

MILE 6.0

MILE 5.0

MILE 4.0

TRUE NORTH

MAGNETIC NORTH

13°

0 250 500 1000

SCALE: 1" = 1000'

DESERT

SMITH

PACIFICORP

BLM

HIGH DESERT

HOBBS

VARIOUS

CHRISTENS

27

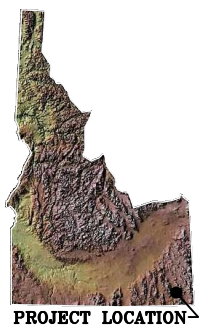
26

35

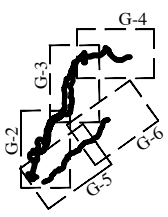
34

3

2



PROJECT LOCATION



SHEET LOCATION

BEAR RIVER NARROWS

HYDROELECTRIC PROJECT
FRANKLIN COUNTY, IDAHO
FERC NO. 12486
EXHIBIT G-3
DAM & RESERVOIR

REFERENCE POINTS METADATA

REFERENCE POINT

COORDINATES BASED ON GEOGRAPHIC NAD 1983 COORDINATE SYSTEM (LATITUDE, LONGITUDE)

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(42.282273, -111.720209)

SPILLWAY ELEV 4887

ONEIDA NARROWS RESERVOIR

Intake

PENSTOCK

PACIFICORP

ONEIDA STATION

ROW = 40'

EXISTING ACCESS ROAD

ROW = 160'

ACCESS ROAD PROJECT BOUNDARY

NEW ACCESS ROAD

ROW = 80'

HICKMAN

STRAWBERRY CREEK

HWY 36

Radio Facility

SMITH

HOBBS

FREE

Spring

Strawberry

23 24 19 20 25 26 30

(42.255961, -111.748178)

(42.255852, -111.704575)

TRUE NORTH

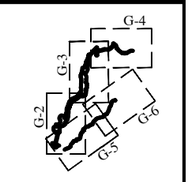
MAGNETIC NORTH

13°

0 250 500 1000

SCALE: 1" = 1000'

PROJECT LOCATION



SHEET LOCATION

PROFESSIONAL LAND SURVEYOR
REGISTERED
Terry R. Meppen 7380
11/8/13
STATE OF IDAHO
TERRY R. MEPPEN

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BEAR RIVER NARROWS

HYDROELECTRIC PROJECT
FRANKLIN COUNTY, IDAHO
FERC NO. 12486
EXHIBIT G-4
ACCESS ROAD

REFERENCE POINTS METADATA

REFERENCE POINT

COORDINATES BASED ON GEOGRAPHIC NAD 1983 COORDINATE SYSTEM (LATITUDE, LONGITUDE)

PACIFICORP

PROJECT BOUNDARY ENDS AT THE CONFLUENCE OF MINK CREEK AND BEAR RIVER

(42.193660, -111.776678)

PROJECT BOUNDARY FOLLOWS CENTERLINE OF MINK CREEK FROM HIGH WATER MARK TO HIGH WATER MARK

(42.219365, -111.739628)

(42.197995, -111.740879)

HWY 36

BLM

EGLEY

CHRISTENSEN

RASMUSSEN

IVERSON

COLL

JEPSEN

ERICKSON

KELLER

HANSEN

DESPAIN

WESTERBERG

SINCLAIR

JENSEN

LARSON

MCKAY

Bear Creek

CANAL

RIVERDALE

PRESTON

TRUE NORTH

MAGNETIC NORTH

13°

0 250 500 1000

SCALE: 1" = 1000'

PROFESSIONAL LAND SURVEYOR
REGISTERED
Terry R. Meppen 11/8/13
7380
STATE OF IDAHO
TERRY R. MEPPEN

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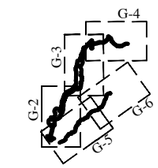
PROJECT LOCATION



SHEET LOCATION

BEAR RIVER NARROWS

HYDROELECTRIC PROJECT
FRANKLIN COUNTY, IDAHO
FERC NO. 12486
EXHIBIT G-5
ACCESS ROAD

REFERENCE POINTS METADATA

⊗ REFERENCE POINT

COORDINATES BASED ON GEOGRAPHIC NAD 1983 COORDINATE SYSTEM (LATITUDE, LONGITUDE)

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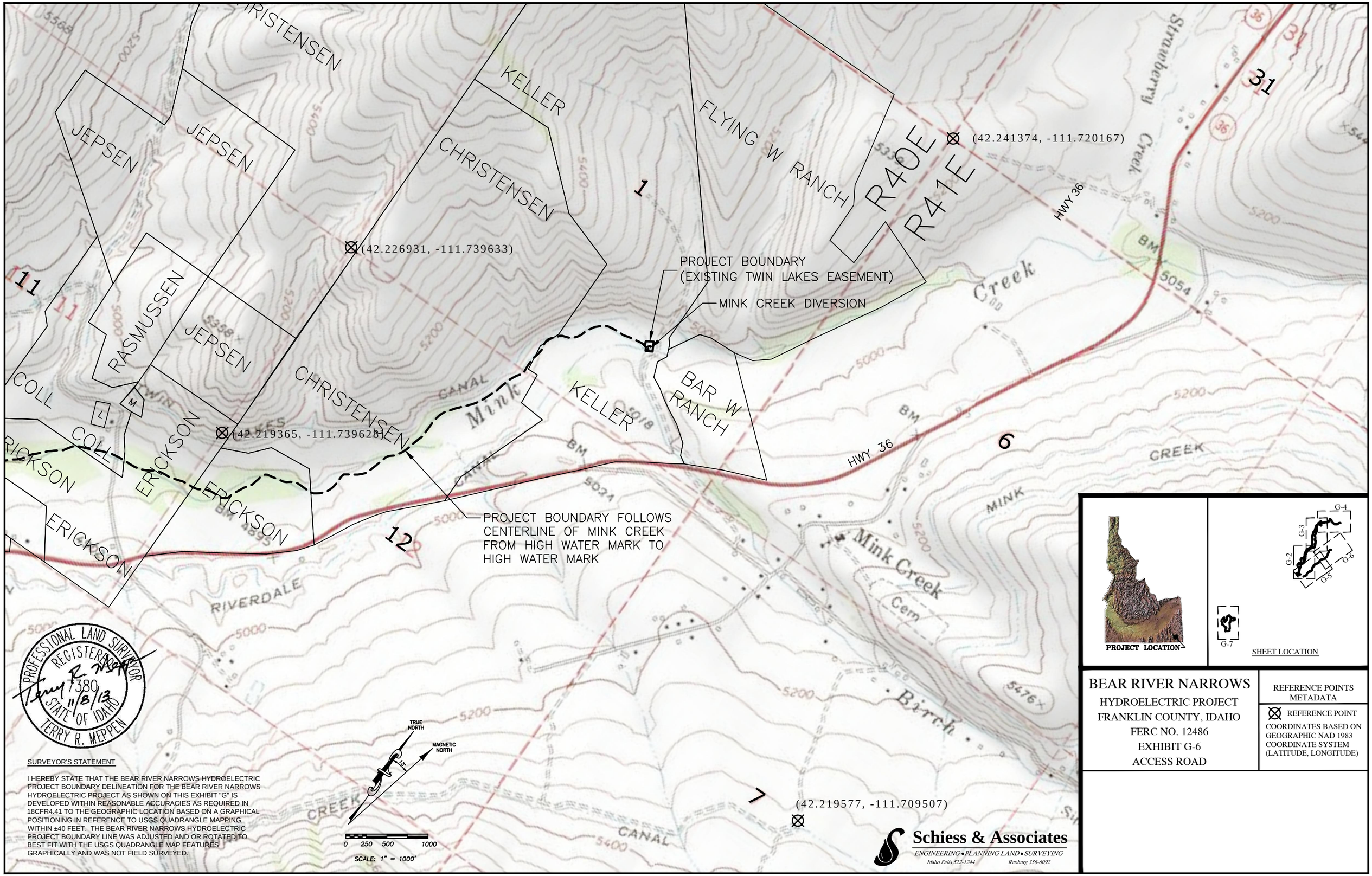
Idaho Falls 522-1244 *Rexburg 356-6092*



SURVEYOR'S STATEMENT

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BEAR RIVER NARROWS
HYDROELECTRIC PROJECT
FRANKLIN COUNTY, IDAHO
FERC NO. 12486
EXHIBIT G-6
ACCESS ROAD

REFERENCE POINTS METADATA

REFERENCE POINT
COORDINATES BASED ON GEOGRAPHIC NAD 1983 COORDINATE SYSTEM (LATITUDE, LONGITUDE)

PROFESSIONAL LAND SURVEYOR
REGISTERED
Terry R. Meppen 7380 11/8/13
STATE OF IDAHO
TERRY R. MEPPEN

SURVEYOR'S STATEMENT

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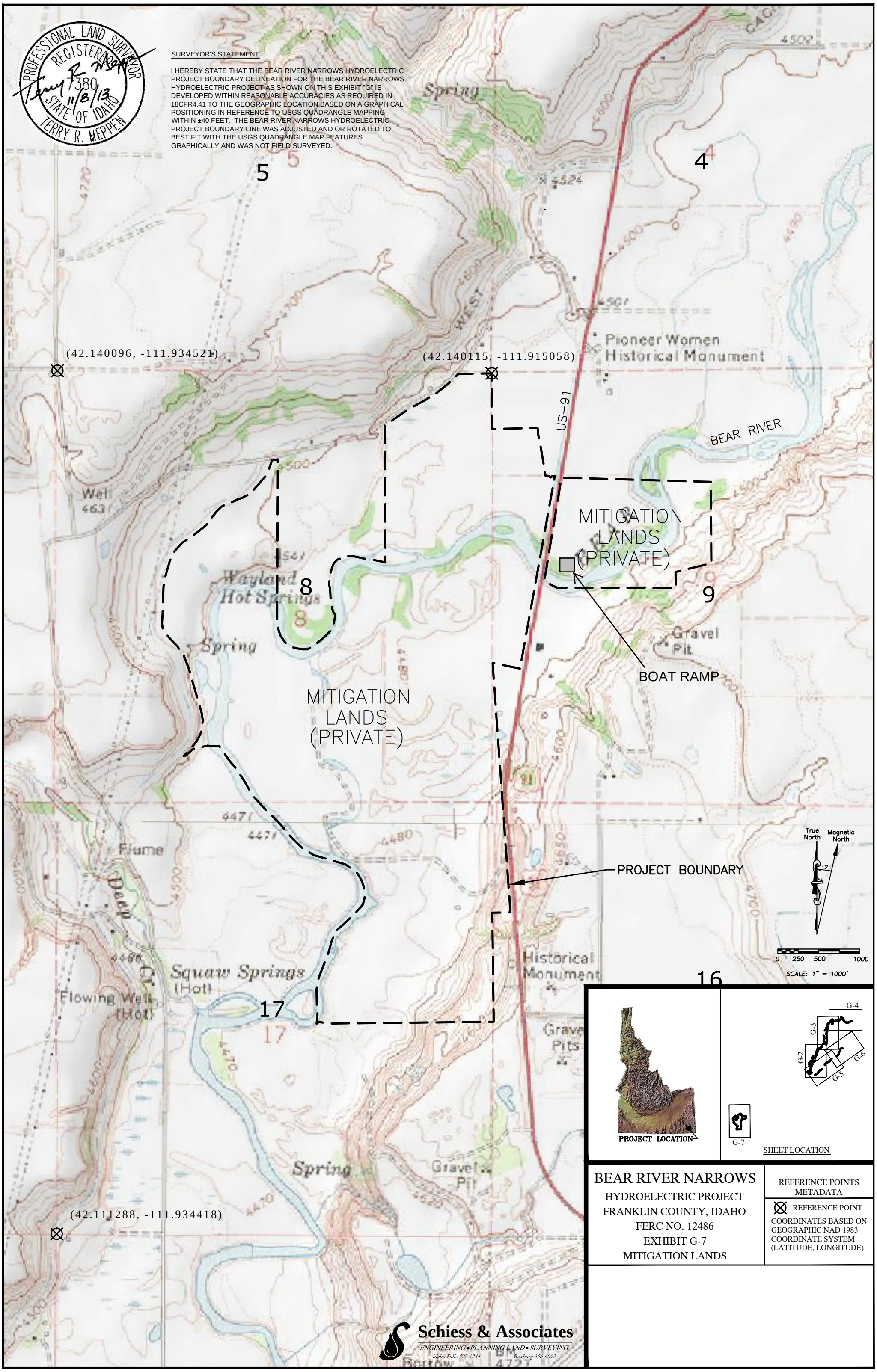

BEAR RIVER NARROWS
HYDROELECTRIC PROJECT
FRANKLIN COUNTY, IDAHO
FERC NO. 12486
EXHIBIT G-7
MITIGATION LANDS

REFERENCE POINTS METADATA

REFERENCE POINT
COORDINATES BASED ON GEOGRAPHIC NAD 1983 COORDINATE SYSTEM (LATITUDE, LONGITUDE)

Schiess & Associates
ENGINEERING • PLANNING LAND • SURVEYING
Idaho Falls 522-1244 Rexburg 356-6092

EXHIBIT E SECTION 7

REPORT ON WATER QUALITY

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7 REPORT ON WATER QUALITY

7.1 WATER QUALITY STANDARDS

The Bear River in the project vicinity is part of Hydrologic Unit No. 16010202, riverine management reach MR4 (Oneida Dam to Mink Creek). The Idaho Administrative Code has designated the Bear River from Alexander Dam to the Utah border (including the proposed project reach) as suitable for the following beneficial uses (IDEQ, 2011a):

- Cold water aquatic life
- Salmonid spawning
- Primary contact recreation
- Agricultural water supply, industrial water supply, wildlife habitat, aesthetics.

The 2010 Integrated Report shows the Bear River from Oneida Dam to the WY/UT border on the Idaho 303(d) list for low flow alterations, phosphorous, temperature and total suspended solids (IDEQ, 2011b). Table E7-1 shows a summary of the Idaho water quality standards for the project reach of the Bear River.

Table E7-1. Idaho numerical water quality criteria for the mainstem Bear River and its tributaries (Source: IDEQ, 2011).

PARAMETER	COLDWATER AQUATIC LIFE	SALMONID SPAWNING	PRIMARY CONTACT RECREATION	OTHER
Temperature	≤22°C instantaneous ≤19°C maximum daily average	≤13°C instantaneous ≤9°C daily average	-	-
Water column dissolved oxygen	≥6 mg/L[a]	≥6 mg/L	-	downstream of existing dams, reservoirs, or hydroelectric facilities[b]: ≥3.5 mg/L instantaneous; ≥4.7 mg/L 7-day mean; ≥6.0 mg/L 30-day mean
Intergravel dissolved oxygen	-	One day minimum ≥5 mg/L and 7 day average ≥6 mg/L	-	-

PARAMETER	COLDWATER AQUATIC LIFE	SALMONID SPAWNING	PRIMARY CONTACT RECREATION	OTHER
Total phosphorous (mg/L)	0.075 mg/L Target concentration at UT-ID state line: 0.05 mg/L	-	-	EPA target goal: 0.025 mg/L lakes and reservoirs; 0.05 mg/L rivers entering into lakes and reservoirs; 0.10 flowing waters not discharged into a lake or reservoir
pH	6.5 – 9.0	-	-	-
Total dissolved gas	≤110% at atmospheric pressure	-	-	-
Turbidity	≤50 NTUs above background instantaneously ≤25 NTUs from background for 10 days	-	-	-
Total suspended solids (mg/L)	80 runoff 60 base flow	-	-	-
E. coli	-	-	Maximum 406/100 ml	-

[a] Does not apply (i) to the bottom 20% of the water depth in natural lakes and reservoirs where depths are 35 meters or less, (ii) the bottom 7 meters where depths are greater than 35 meters, or (iii) those waters of the hypolimnion in stratified lakes and reservoirs (IDEQ 2011, Section 250.02.a.i-iii)
[b] Supersedes other criteria from 15-Jun to 15-Oct

In addition to enforceable numeric criteria within the water quality standards, the state has narrative criteria for pollutants such as nutrients (e.g. phosphorus and nitrate) and sediment. Generally, one nutrient, usually phosphorus, is the limiting factor in aquatic environments. It appears that the limiting factor for most of the year in the Bear River is phosphorus. Water quality targets for sediment and total phosphorus differ based on location within a riverine management reach, depending on whether water flowing past that site discharges into a lake or impoundment (reservoir).

7.2 Existing Water Quality Conditions

A number of water quality assessments have been carried out within the project area as listed in Table E7-2. Ecosystems Research Institute (2006) summarized historical flow and water quality data through 2006 in the project area as part of the Bear River Basin Assessment carried out for Idaho DEQ during the Total Maximum Daily Load development. In addition, Gerner and Spangler (2006) published the results of a 2001 study of water quality in the project area as related to snowmelt. Barker et al. (1989) studied the bioavailability of phosphorus in the Bear River in the

late 1980s. Additional data for the Bear River and its tributaries for historical comparison purposes were obtained from the U.S. EPA's STORET system, the widely used public data repository for water quality and other water-related data collected to support the Clean Water Act, and from the US Geological Survey's NWIS water-related data repository.

Table E7-2. Summary of historical water quality studies and data sources in the project area.

STUDY	TIME PERIOD	AGENCY	REMARKS	REFERENCE
Spring runoff	2001	USGS	Spring runoff assessment – many parameters	Gerner and Spangler, 2006
TMDL assessment	1990 – 2000	IDEQ	TMDL assessment	Ecosystems Research Institute, 2006
Bear River nutrients	1989	UWRL	Biologically available phosphorus	Barker et.al. 1989
Ambient water quality monitoring	1998 – 2003	IDEQ	Routine ambient monitoring by UDEQ Water Quality Division	STORET, 2009
NWIS database	1954 – current	USGS	National Water Information System	USGS, 2011

Under Study 5 Water Quality of the FERC Study Plan for the proposed project (FERC, 2007), Twin Lakes Canal Company collected new water quality data in the Bear River, Oneida Reservoir, and tributaries to the Bear River during 2009 and 2010 (Stevens & Milleson, 2013). The monitoring stations are shown in Figure E7-1. Each Bear River mainstem and tributary site was sampled routinely once per month during the year, with an increased frequency of twice monthly during spring runoff (March, April, and May). Storm events were monitored on three occasions at 3-4 sites, and additional samples were obtained for estimation of event mean concentrations for selected subwatersheds. The four Oneida reservoir sites were likewise monitored monthly when the reservoir was ice-free and depth profiles of a number of physical and water quality measures were obtained at each site.

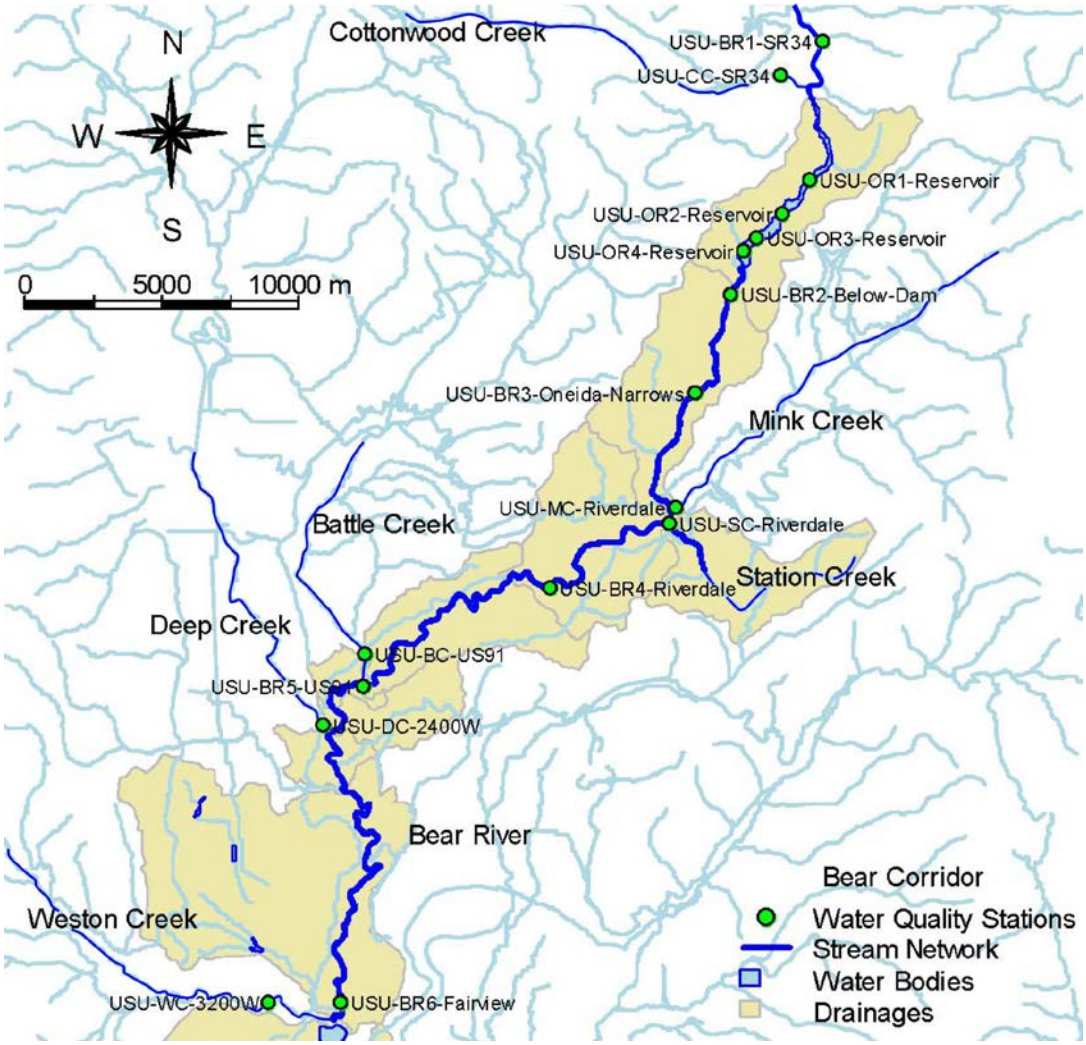


Figure E7-1. Map of Oneida Narrows Project area showing Bear River, Oneida Reservoir, and Tributary Monitoring locations.

7.2.1 BEAR RIVER MAINSTEM

Six stations on the Bear River mainstem were monitored monthly between January and December 2009. Observations were made of dissolved oxygen, temperature, pH, specific conductance, turbidity, total phosphorus and nitrogen, and suspended solids. The data are summarized in Figures E7-2 and E7-3 and in Table E7-3. Five stations that correspond approximately to five of the six the 2009 study stations on the Bear River mainstem were identified from the historical database and the data summary for these stations is found in Table E7-4. Additional summaries and discussion of other water quality constituents are found in the Study 5 report (Stevens & Milleson, 2013).

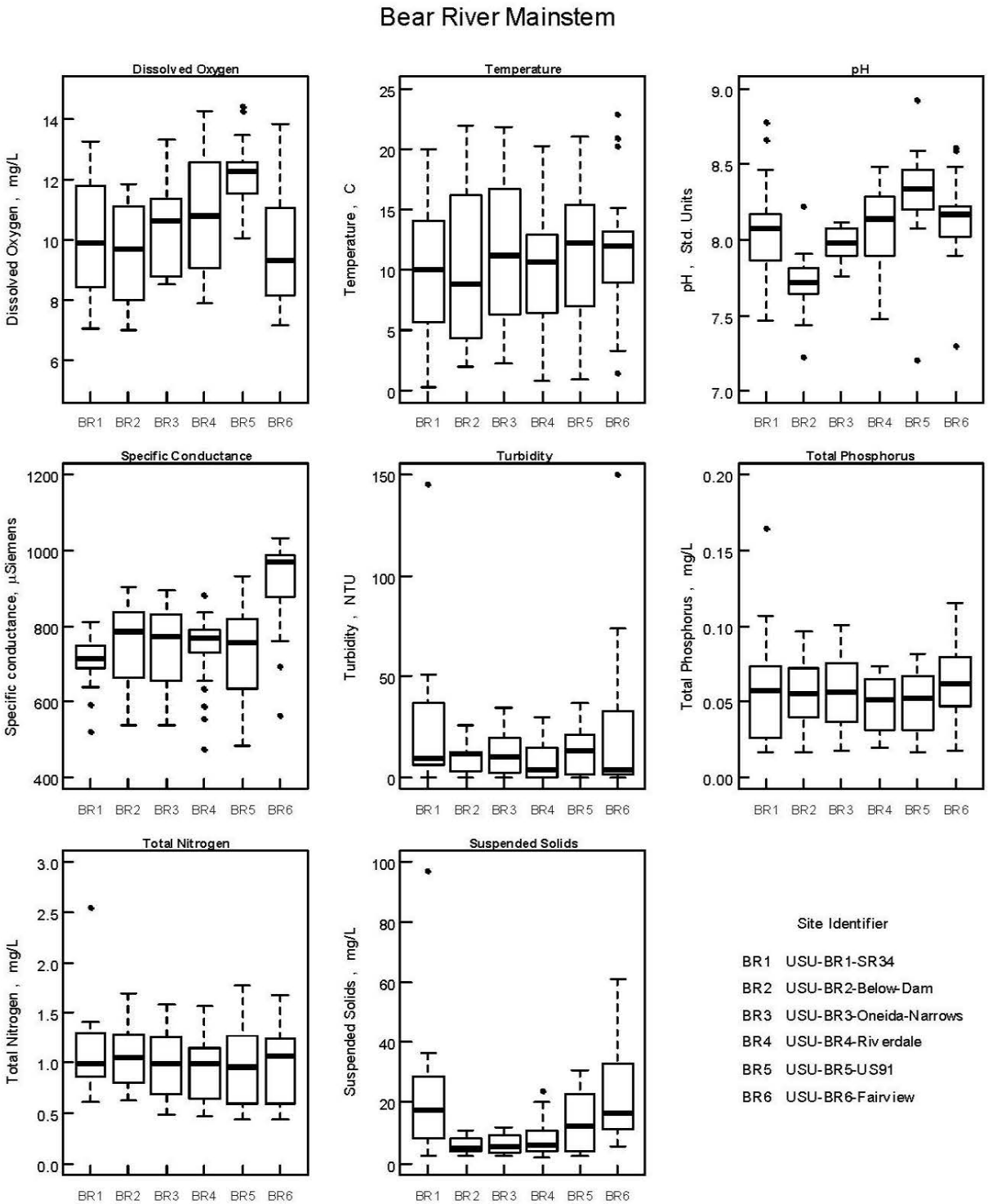


Figure E7-2. Summary box-whisker plots for Bear River mainstem stations.

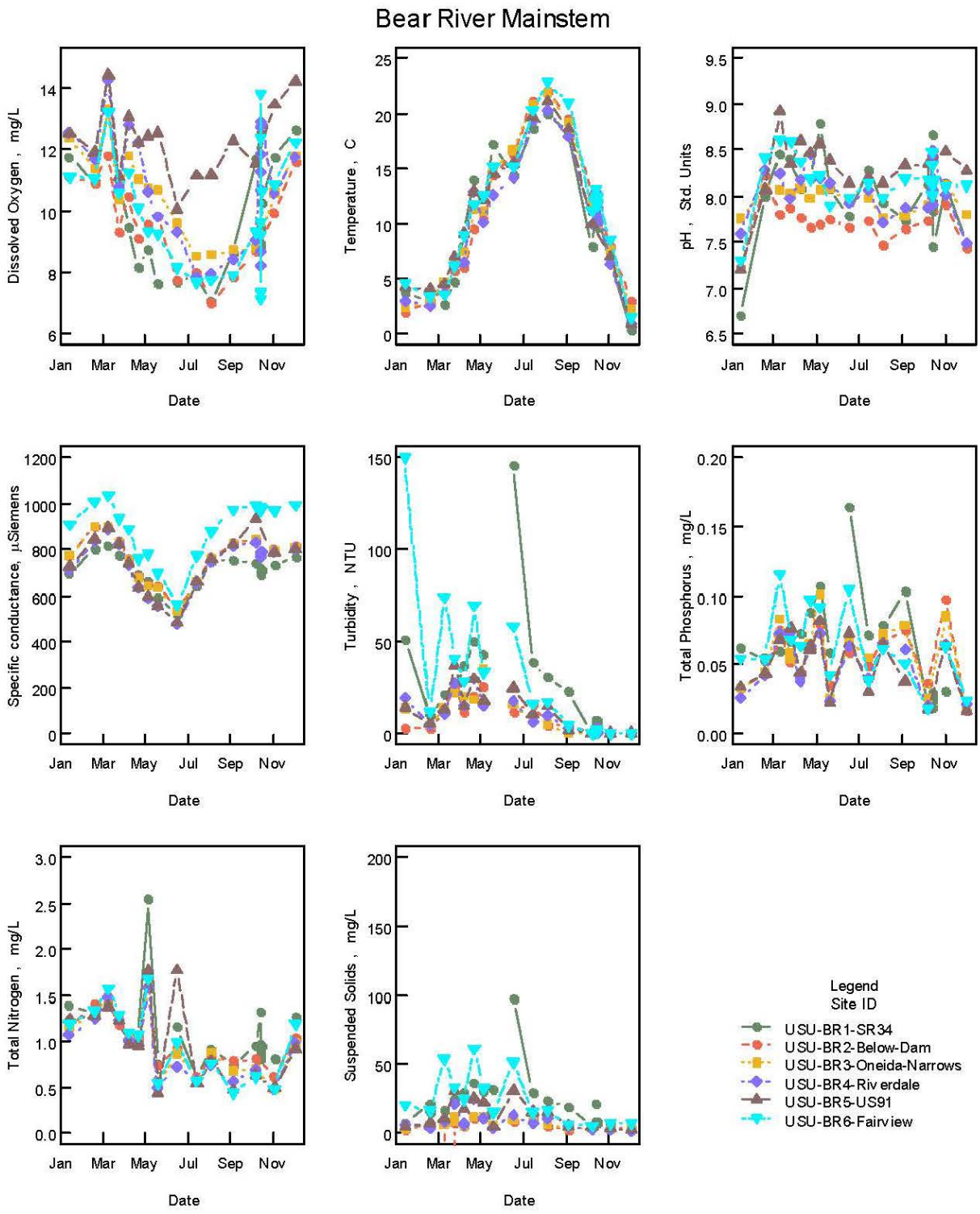


Figure E7-3. Summary time series plots for Bear River mainstem stations.

Table E7-3. Water quality data summaries - Bear River mainstem stations, 2009.

Station	Minimum	1st Qu.	Median	Mean	3rd Qu.	Maximum	Standard Deviation	Median Absolute Deviation[a]	Inter-quartile Range	Count
All data										
Dissolved Oxygen, mg/L	7.00	8.89	10.78	10.50	11.81	14.43	1.86	2.15	2.92	98
Temperature, C	0.31	4.64	10.23	10.62	15.97	22.81	6.44	8.38	11.34	98
pH	6.70	7.80	8.08	8.03	8.22	8.92	0.35	0.29	0.41	98
Specific Conductance, µSiemens	475.8	659.3	762.0	754.1	822.5	1036.0	121.7	112.7	163.2	98
Turbidity, NTU	0.0	4.6	13.7	19.2	24.7	150.0	25.0	16.0	20.1	98
Total Phosphorus, mg/L	0.019	0.044	0.062	0.061	0.073	0.164	0.024	0.019	0.029	98
Total Nitrogen, mg/L	0.291	0.739	1.005	1.026	1.285	2.543	0.400	0.406	0.546	98
Suspended Solids, mg/L	1.6	5.2	8.6	14.5	20.3	97.1	15.0	8.0	15.1	98
Site: BR1										
Dissolved Oxygen, mg/L	7.04	7.97	10.23	9.93	11.74	13.27	2.02	2.31	3.78	18
Temperature, C	0.31	3.92	8.52	9.87	16.42	19.92	6.51	8.32	12.50	18
pH	6.70	7.95	8.09	8.02	8.18	8.78	0.44	0.19	0.23	18
Specific Conductance, µSiemens	520.1	668.8	732.7	709.7	765.5	812.0	81.0	63.2	96.725	18
Turbidity, NTU	0.0	7.2	23.9	30.2	39.7	146.0	35.8	25.1	32.6	18
Total Phosphorus, mg/L	0.019	0.057	0.066	0.073	0.083	0.164	0.035	0.018	0.026	18
Total Nitrogen, mg/L	0.603	0.859	1.041	1.149	1.350	2.543	0.465	0.391	0.491	18
Suspended Solids, mg/L	2.4	13.1	22.7	24.6	30.0	97.1	22.0	11.7	17.0	18
Site BR2										
Dissolved Oxygen, mg/L	7.00	8.03	9.84	9.72	11.10	11.83	1.63	2.60	3.07	17
Temperature, C	2.00	4.36	7.99	10.08	16.17	21.91	6.96	7.50	11.81	17
pH	7.22	7.64	7.74	7.70	7.81	8.22	0.23	0.12	0.17	17
Specific Conductance, µSiemens	539.2	663.0	800.2	763.0	838.0	902.6	117.2	67.6	175.0	17
Turbidity, NTU	0.0	2.2	8.2	8.9	12.4	25.7	8.3	7.7	10.2	17
Total Phosphorus, mg/L	0.032	0.044	0.055	0.058	0.074	0.097	0.019	0.025	0.029	17
Total Nitrogen, mg/L	0.618	0.793	1.014	1.055	1.350	1.696	0.348	0.373	0.557	17
Suspended Solids, mg/L	2.2	3.5	5.1	5.8	7.4	10.7	2.7	2.9	3.9	17
Site BR3										
Dissolved Oxygen, mg/L	8.52	10.00	10.69	10.65	11.59	13.33	1.42	1.59	1.59	15
Temperature, C	2.25	5.47	7.56	10.49	15.77	21.85	6.94	6.70	10.30	15
pH	7.76	7.97	8.03	7.99	8.08	8.12	0.12	0.07	0.11	15
Specific Conductance, µSiemens	536.5	656.8	758.8	742.8	821.4	897.2	105.9	127.2	164.6	15
Turbidity, NTU	0.0	5.6	13.9	13.3	19.9	34.8	9.9	11.0	14.3	15
Total Phosphorus, mg/L	0.025	0.044	0.059	0.060	0.072	0.101	0.022	0.022	0.028	15
Total Nitrogen, mg/L	0.476	0.870	1.077	1.034	1.268	1.576	0.349	0.307	0.398	15
Suspended Solids, mg/L	2.4	5.4	5.6	6.9	9.3	12.0	3.3	4.3	3.9	15
Site BR4										
Dissolved Oxygen, mg/L	7.88	9.11	10.72	10.72	12.32	14.28	2.00	2.49	3.21	16
Temperature, C	0.85	5.54	8.27	10.17	14.96	20.22	6.68	7.32	9.43	16
pH	7.48	7.84	8.04	8.00	8.18	8.46	0.27	0.23	0.35	16
Specific Conductance, µSiemens	475.8	649.6	740.7	720.3	802.6	884.0	112.1	113.9	152.9	16
Turbidity, NTU	0.0	5.3	10.5	12.1	16.2	29.5	8.9	8.6	10.9	16
Total Phosphorus, mg/L	0.023	0.040	0.062	0.053	0.065	0.073	0.018	0.016	0.025	16
Total Nitrogen, mg/L	0.471	0.612	0.993	0.939	1.190	1.575	0.359	0.384	0.578	16
Suspended Solids, mg/L	1.6	4.6	6.5	8.6	10.7	24.1	6.4	4.2	6.1	16
Site BR5										
Dissolved Oxygen, mg/L	10.07	11.74	12.28	12.33	12.68	14.43	1.14	0.86	0.95	16
Temperature, C	0.95	6.38	12.54	11.40	16.16	21.03	6.31	8.55	9.78	16
pH	7.20	8.19	8.34	8.30	8.47	8.92	0.36	0.21	0.28	16
Specific Conductance, µSiemens	482.4	635.0	746.3	722.3	818.3	893.0	116.7	122.2	183.3	16
Turbidity, NTU	0.0	3.6	14.0	14.2	21.2	36.9	11.7	15.6	17.7	16
Total Phosphorus, mg/L	0.022	0.039	0.062	0.054	0.068	0.081	0.019	0.024	0.029	16
Total Nitrogen, mg/L	0.430	0.605	0.975	1.019	1.273	1.769	0.449	0.524	0.668	16
Suspended Solids, mg/L	2.6	4.4	15.2	14.3	22.8	30.7	10.1	14.1	18.4	16
Site BR6										
Dissolved Oxygen, mg/L	7.68	9.00	9.34	9.78	10.92	13.24	1.53	1.99	1.92	16
Temperature, C	3.37	7.98	11.52	11.82	15.16	22.81	6.00	5.42	7.19	16
pH	7.30	8.07	8.19	8.16	8.26	8.61	0.30	0.20	0.19	16
Specific Conductance, µSiemens	562.2	778.0	900.0	870.6	977.4	1036.0	133.1	147.3	199.4	16
Turbidity, NTU	0.0	8.2	28.5	35.9	49.6	150.0	40.0	35.4	41.4	16
Total Phosphorus, mg/L	0.039	0.054	0.062	0.069	0.086	0.116	0.024	0.014	0.032	16
Total Nitrogen, mg/L	0.291	0.551	1.028	0.950	1.262	1.671	0.441	0.569	0.711	16
Suspended Solids, mg/L	5.4	15.0	18.4	25.6	32.9	61.4	18.4	17.1	17.9	16

Table E7-4. Water quality data summaries - Bear River mainstem, historical data.

Station	Minimum	1st Qu.	Median	Mean	3rd Qu.	Maximum	Standard Deviation	Median Absolute Deviation[b]	Inter-quartile Range	Count
Station: 4906100 (BR6[c])										
Dissolved Oxygen	5.17	7.96	9.2	9.32	10.8	15.9	1.92	2.15	2.79	155
Temperature	0.00	4.30	10.80	10.51	15.77	23.30	6.90	8.33	11.47	153
pH	6.00	8.07	8.20	8.17	8.32	9.20	0.297	0.178	0.25	291
Specific Conductance	7.61	776.	898.00	889.60	1007.	1794.	203.12	171.98	231.	283
Turbidity	0.98	4.63	7.5	14.45	14.5	190.0	23.78	6.079	9.87	135
Total Phosphorus	0.0	0.038	0.056	0.077	0.087	0.595	0.083	0.0230	0.049	141
Total Nitrogen	0.0	0.23	0.42	0.4789	0.71	1.17	0.32	0.32	0.48	35
Suspended Solids	0.000	10.6	18.9	33.9	30.95	889.	78.2	14.7	20.4	150
Station: 4906140 (BR4)										
Dissolved Oxygen, mg/L										
Temperature, C	0.30	2.20	7.65	8.48	12.80	22.00	6.92	8.08	10.60	24
pH	7.49	7.90	8.15	8.11	8.24	9.39	0.296	0.222	0.345	52
Specific Conductance, µSiemens	473.	603.	685.	674.	708.5	1440.	161.3	59.3	105.5	35
Turbidity, NTU	2.56	4.12	6.26	8.847	9.71	33.8	8.121	4.314	5.59	29
Total Phosphorus, mg/L	0.026	0.035	0.08	0.074	0.087	0.214	0.053	0.043	0.052	11
Total Nitrogen, mg/L	1.11	1.11	1.11	1.11	1.11	1.1	-	0.0	0.0	1
Suspended Solids, mg/L	0.0	4.3	10.2	13.4	15.2	62.8	14	8.9	10.9	28
Station: 4906150 (BR5)										
Dissolved Oxygen, mg/L	3.8	5.85	7.95	7.66	9.0	13.0	2.38	2.82	3.15	22
Temperature, C	0.00	4.05	10.35	10.59	16.58	25.40	7.19	9.34	12.53	158
pH	7.20	8.08	8.23	8.21	8.38	8.90	0.266	0.222	0.295	314
Specific Conductance, µSiemens	418.	670.	724.	712.8	784.	930.	99.6	87.5	114.	287
Turbidity, NTU	0.67	3.0	5.6	8.2	10.1	60.8	8.2	4.6	7.19	178
Total Phosphorus, mg/L	0.0	0.02	0.036	0.042	0.059	0.124	0.028	0.023	0.039	67
Total Nitrogen, mg/L	0.10	0.20	0.3	0.43	0.60	1.10	0.28	0.25	0.40	29
Suspended Solids, mg/L	0.0	5.2	11.2	17.1	24.6	113.6	18.3	13.3	19.4	170
Station: 4906160 (BR4)										
Dissolved Oxygen, mg/L	0.0	9.4	10.2	9.66	11.0	13.2	2.66	1.19	1.6	20
Temperature, C	0.00	3.50	7.00	8.07	12.00	18.50	5.73	5.93	8.50	15
pH	6.15	8.05	8.22	8.05	8.27	8.55	0.509	0.208	0.22	21
Specific Conductance, µSiemens	680.	778.	843.5	813.7	864.8	918.	75.5	70.4	86.5	14
Turbidity, NTU	-	-	-	-	-	-	-	-	-	-
Total Phosphorus, mg/L	0.006	0.035	0.043	0.075	0.065	0.334	0.08917	0.019	0.03	20
Total Nitrogen, mg/L	-	-	-	-	-	-	-	-	-	-
Suspended Solids, mg/L	1.0	4.0	5.0	6.3	8.0	14.0	3.8	2.9	4.0	21
Station: 4906200 (BR2)										
Dissolved Oxygen, mg/L	7.5	8.4	9.0	9.55	10.2	13.8	1.85	1.48	1.8	17
Temperature, C	0.00	4.50	8.00	8.43	12.00	18.00	5.67	5.93	7.50	17
pH	5.81	7.43	7.75	7.50	8.02	8.43	0.774	0.474	0.59	21
Specific Conductance, µSiemens	734.	802.2	885.5	864.9	923.5	1017.	86.5	94.9	121.3	14
Turbidity, NTU	-	-	-	-	-	-	-	-	-	-
Total Phosphorus, mg/L	0.023	0.052	0.059	0.1311	0.079	1.08	0.238	0.0178	0.026	20
Total Nitrogen, mg/L	-	-	-	-	-	-	-	-	-	-
Suspended Solids, mg/L	1.0	4.0	5.0	6.1	8.0	20.0	4.2	3.0	4.0	21

7.2.2 BEAR RIVER TRIBUTARIES

Six stations on important tributaries to the Bear River were monitored between March and December 2009. The locations of these stations are shown on Figure E7-1. Observations were made for dissolved oxygen, temperature, pH, specific conductance, turbidity, total phosphorus and nitrogen, and suspended solids. These data are summarized in Figure E7-4 and Figure E7-5 and in Table E7-5. Four historical monitoring stations were identified that correspond approximately to the 2009 study tributary stations and the data summary for these stations is found in Table E7-6. Additional summaries and discussion of other water quality constituents are found in the Study 5 report (Stevens & Milleson, 2013).

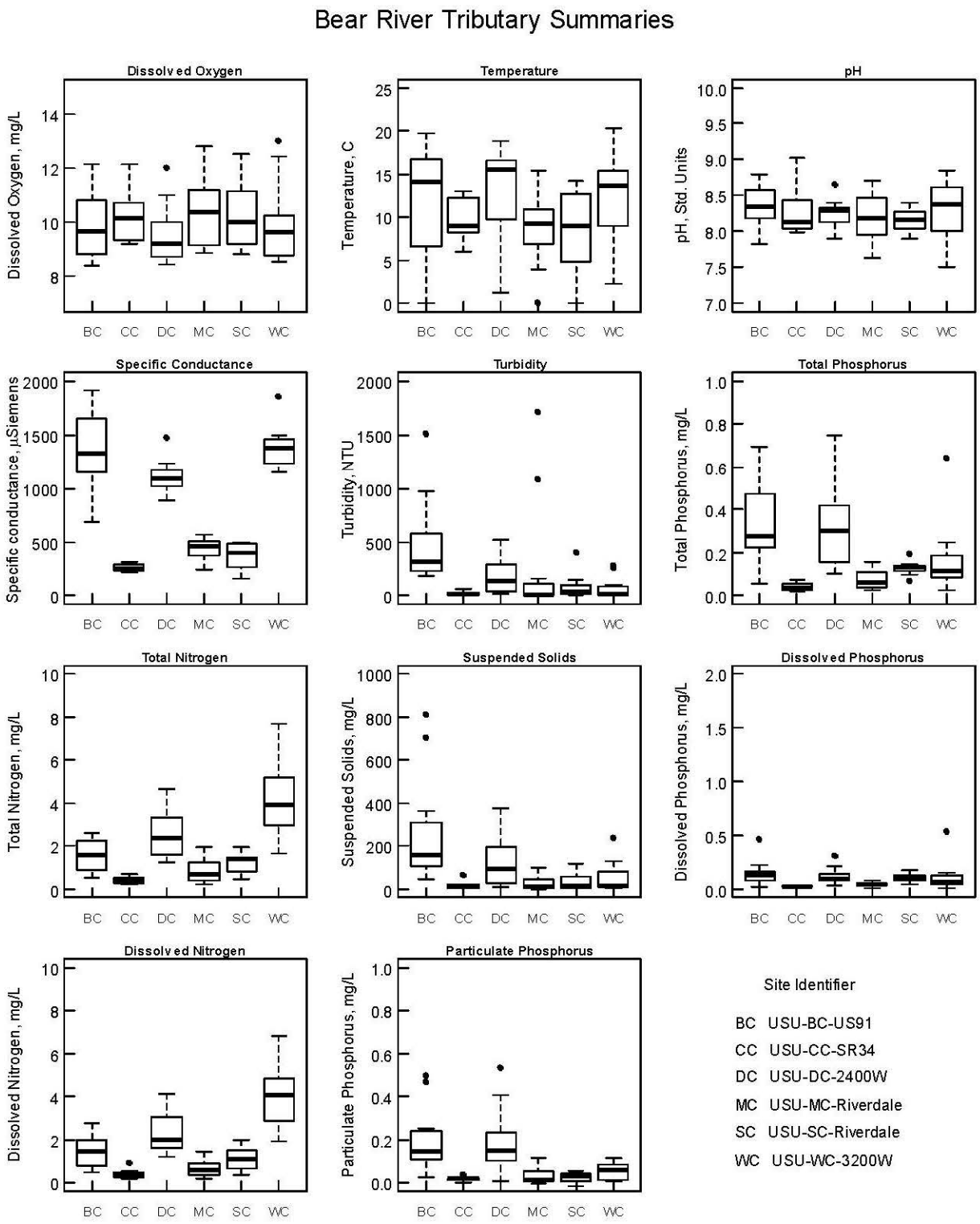


Figure E7-4. Summary box-whisker plots for Bear River Tributary Stations.

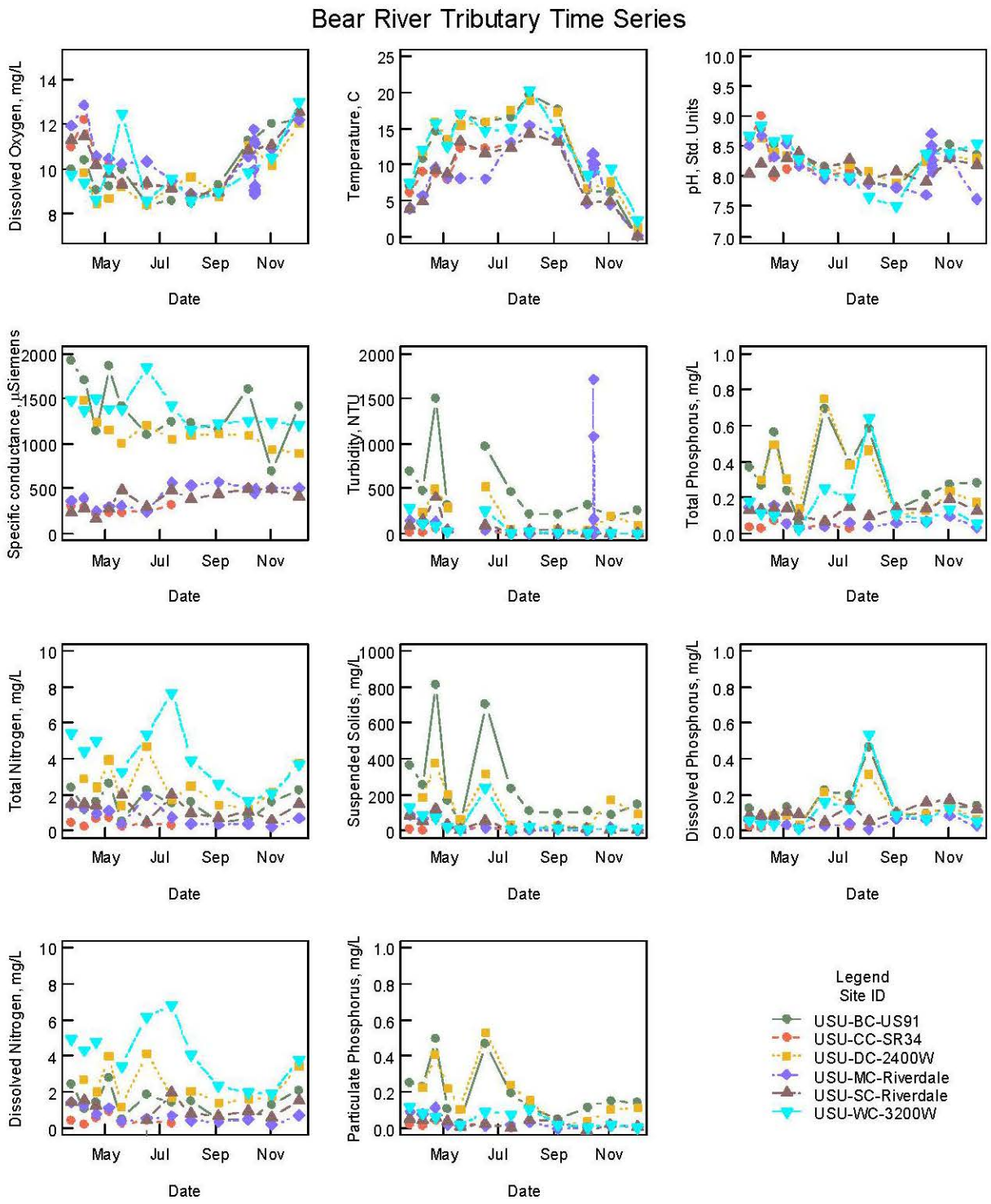


Figure E7-5. Summary time series plots for Bear River Tributary Stations.

Table E7-5. Water quality data summaries - Bear River Tributary Stations.

Station/Constituent	Mini-mum	1st Qu.	Median	Mean	3rd Qu.	Maximum	Standard Deviation	Median Absolute Deviation[d]	Inter-quartile Range	Count
All Tributaries										
Dissolved Oxygen, mg/L	8.37	9.09	9.85	10.07	10.94	13.00	1.23	1.30	1.85	74
Temperature, C	-0.01	7.51	10.59	10.56	14.43	20.28	4.91	5.44	6.92	74
pH	7.51	8.05	8.26	8.25	8.41	9.02	0.303	0.304	0.362	74
Specific Conductance, µSiemens	165.0	394.4	548.9	813.7	1225	1920.0	500.1	475.7	830.3	74
Turbidity, NTU	0.0	6.5	42.6	189.2	219.0	1717.0	331.6	63.16	212.5	68
Total Phosphorus, mg/L	0.0202	0.065	0.1329	0.1867	0.237	0.7488	0.1725	0.1121	0.1716	65
Total Nitrogen, mg/L	0.207	0.683	1.473	1.850	2.405	7.682	1.536	1.229	1.721	64
Suspended Solids, mg/L	1.5	10.27	29.75	92.87	106.7	809.3	148.3	39.96	96.45	66
Dissolved Phosphorus, mg/L	0.0063	0.037	0.0825	0.0965	0.123	0.5354	0.09343	0.06449	0.0861	65
Dissolved Nitrogen, mg/L	0.178	0.578	1.386	1.742	2.072	6.813	1.507	1.161	1.494	63
Site: Battle Creek (BC)										
Dissolved Oxygen, mg/L	8.37	8.95	9.66	9.91	10.61	12.18	1.32	1.33	1.66	12
Temperature, C	-0.01	6.75	13.97	12.09	16.68	19.71	6.01	5.03	9.93	12
pH	7.83	8.19	8.34	8.35	8.55	8.80	0.297	0.289	0.365	12
Specific Conductance, µSiemens	686.8	1153.	1331.0	1373.2	1632.	1920.0	356.2	317.3	479.2	12
Turbidity, NTU	187.5	236.6	320.0	510.9	582.0	1509.0	408.2	196.4	345.4	11
Total Phosphorus, mg/L	0.0537	0.231	0.2797	0.3384	0.432	0.6930	0.1915	0.1474	0.2002	12
Total Nitrogen, mg/L	0.503	1.038	1.586	1.557	2.245	2.594	0.731	0.980	1.207	12
Suspended Solids, mg/L	47.5	106.1	158.7	260.8	279.9	809.3	247.9	110.1	173.7	12
Dissolved Phosphorus, mg/L	0.0264	0.080	0.1235	0.1437	0.155	0.4636	0.1166	0.07005	0.07515	12
Dissolved Nitrogen, mg/L	0.467	0.919	1.413	1.442	1.897	2.774	0.760	0.814	0.978	12
Site: Cottonwood Creek (CC)										
Dissolved Oxygen, mg/L	9.21	9.32	10.14	10.23	10.71	12.18	1.09	1.20	1.39	7
Temperature, C	6.00	8.29	8.90	9.84	12.19	13.00	2.64	4.30	3.91	7
pH	7.99	8.04	8.12	8.30	8.44	9.02	0.39	0.193	0.40	7
Specific Conductance, µSiemens	219.0	231.8	254.4	262.9	296.5	310.3	37.65	52.48	64.65	7
Turbidity, NTU	0.0	8.325	19.15	21.9	26.98	58.8	20.91	15.79	18.65	6
Total Phosphorus, mg/L	0.0202	0.027	0.0378	0.0428	0.056	0.0741	0.01982	0.02535	0.02885	7
Total Nitrogen, mg/L	0.229	0.274	0.414	0.428	0.540	0.725	0.194	0.244	0.267	7
Suspended Solids, mg/L	2.0	6.1	14.0	18.99	20.65	63.4	21.01	13.79	14.55	7
Dissolved Phosphorus, mg/L	0.0080	0.019	0.0265	0.0253	0.035	0.0364	0.01073	0.01290	0.01585	7
Dissolved Nitrogen, mg/L	0.206	0.258	0.383	0.418	0.469	0.881	0.235	0.213	0.211	7
Site: Deep Creek (DC)										
Dissolved Oxygen, mg/L	8.42	8.71	9.22	9.58	10.00	12.03	1.13	0.92	1.28	11
Temperature, C	1.19	9.70	15.48	12.89	16.63	18.79	5.54	3.02	6.93	11
pH	7.89	8.13	8.29	8.25	8.33	8.64	0.199	0.148	0.195	11
Specific Conductance, µSiemens	891.7	1024.	1096.0	1113.2	1181	1478.0	160.7	134.9	156.5	11
Turbidity, NTU	17.9	44.45	141.1	196.6	275.0	521.0	187.2	151.4	230.6	10
Total Phosphorus, mg/L	0.1034	0.157	0.3020	0.3151	0.423	0.7488	0.1962	0.2387	0.2659	11
Total Nitrogen, mg/L	1.216	1.599	2.398	2.550	3.308	4.670	1.144	1.415	1.710	11
Suspended Solids, mg/L	10.8	29.95	94.4	136.3	195.2	374.6	124.9	111.0	165.2	11
Dissolved Phosphorus, mg/L	0.0364	0.082	0.0916	0.1217	0.137	0.3128	0.0795	0.04374	0.0549	11
Dissolved Nitrogen, mg/L	1.186	1.615	2.003	2.352	3.050	4.148	1.056	0.930	1.435	11
Site: Mink Creek (MC)										
Dissolved Oxygen, mg/L	8.87	9.18	10.39	10.37	11.17	12.84	1.22	1.58	1.98	20
Temperature, C	0.02	7.39	9.25	8.77	10.59	15.42	3.68	2.51	3.20	20
pH	7.62	7.96	8.18	8.20	8.45	8.71	0.316	0.356	0.49	20
Specific Conductance, µSiemens	241.0	381.5	461.8	436.9	505.2	571.3	98.1	67.24	123.7	20
Turbidity, NTU	0.0	0.0	6.5	182.6	118.0	1717.0	444.6	9.637	118.0	19
Total Phosphorus, mg/L	0.0257	0.038	0.05965	0.0744	0.102	0.1563	0.04505	0.03632	0.06338	12
Total Nitrogen, mg/L	0.207	0.386	0.714	0.827	1.153	1.948	0.543	0.538	0.767	12
Suspended Solids, mg/L	1.5	3.25	10.9	28.17	36.88	101.4	36.65	13.34	33.62	12
Dissolved Phosphorus, mg/L	0.0063	0.027	0.04165	0.0420	0.059	0.0840	0.02273	0.02372	0.0317	12
Dissolved Nitrogen, mg/L	0.178	0.403	0.593	0.681	0.841	1.414	0.388	0.295	0.438	12

Con't Station/Constituent	Mini-mum	1st Qu.	Median	Mean	3rd Qu.	Maximum	Standard Deviation	Median Absolute Deviation[e]	Inter-quartile Range	Count
Site: Station Creek (SC)										
Dissolved Oxygen, mg/L	8.82	9.27	9.99	10.22	11.12	12.55	1.19	1.39	1.85	12
Temperature, C	0.02	4.77	8.95	8.37	12.49	14.22	4.63	6.18	7.72	12
pH	7.90	8.05	8.16	8.15	8.27	8.39	0.153	0.170	0.222	12
Specific Conductance, µSiemens	165.0	273.2	396.9	367.7	480.9	498.7	116.8	146.8	207.7	12
Turbidity, NTU	0.0	12.1	36.7	79.66	95.9	401.0	116.5	54.41	83.8	11
Total Phosphorus, mg/L	0.0682	0.121	0.1347	0.1291	0.141	0.1920	0.03083	0.01030	0.0200	12
Total Nitrogen, mg/L	0.453	0.843	1.392	1.238	1.496	1.985	0.521	0.614	0.653	11
Suspended Solids, mg/L	3.1	6.825	19.25	34.52	55.12	120.4	36.84	21.35	48.3	12
Dissolved Phosphorus, mg/L	0.0451	0.082	0.0959	0.1038	0.129	0.1740	0.03955	0.02943	0.0453	12
Dissolved Nitrogen, mg/L	0.394	0.704	1.071	1.099	1.478	1.949	0.496	0.617	0.774	10
Site: Weston Creek (WC)										
Dissolved Oxygen, mg/L	8.55	8.87	9.63	9.93	10.12	13.00	1.44	1.14	1.25	12
Temperature, C	2.27	9.21	13.59	12.48	15.20	20.28	4.89	4.23	5.98	12
pH	7.51	8.02	8.38	8.29	8.60	8.84	0.417	0.40	0.57	12
Specific Conductance, µSiemens	1157.0	12334	1378.5	1374.7	1443.	1852.0	188.8	182.4	209.8	12
Turbidity, NTU	0.9	8.6	19.3	73.08	94.05	280.0	102.4	23.72	85.45	11
Total Phosphorus, mg/L	0.0280	0.085	0.1141	0.1696	0.187	0.6396	0.1688	0.09029	0.1025	11
Total Nitrogen, mg/L	1.637	2.949	3.925	4.103	5.171	7.682	1.741	1.949	2.223	11
Suspended Solids, mg/L	3.5	10.15	16.05	51.26	75.6	234.9	70.57	12.68	65.45	12
Dissolved Phosphorus, mg/L	0.0120	0.043	0.0676	0.1168	0.124	0.5354	0.1457	0.04907	0.08155	11
Dissolved Nitrogen, mg/L	1.920	2.885	4.057	4.045	4.859	6.813	1.605	1.279	1.974	11

Table E7-6. Water quality data summaries - Bear River Tributaries, historical data.

Station/Constituent	Mini-mum	1st Qu.	Median	Mean	3rd Qu.	Maximum	Standard Deviation	Median Absolute Deviation[f]	Inter-quartile Range	Count
Station: 4906080										
Dissolved Oxygen, mg/L	0.0	9.12	10.0	10.2	11.8	19.0	4.64	1.48	2.62	10
Temperature, C	6.50	7.00	8.00	10.17	14.00	15.00	3.76	2.22	7.00	9
pH	8.10	8.19	8.27	8.22	8.28	8.28	0.101	0.0148	0.09	3
Specific Conductance, µSiemens	1070.	1179.	1240.00	1275.	1356.	1546.	160.3	166.05	177.00	7
Turbidity, NTU	2.2	2.275	2.35	153.8	229.7	457.0	262.5	0.2224	227.4	3
Total Phosphorus, mg/L	0.02	0.067	0.0845	0.1164	0.106	0.608	0.1450	0.03113	0.03875	14
Total Nitrogen, mg/L	2.6900	2.69	2.6900	2.6900	2.69	2.69	NA	0.0	0.0	1
Suspended Solids, mg/L	7.000	13.10	20.000	83.460	38.5	804.	208.8	13.3	25.4	14
Dissolved Phosphorus, mg/L	-	-	-	-	-	-	-	-	-	-
Dissolved Nitrogen, mg/L	0.003	0.009	0.012	0.2404	0.017	1.51	0.5569	0.00593	0.008	13
Station: 4906120										
Dissolved Oxygen, mg/L	8.6	9.2	10.4	10.3	11.1	12.2	1.31	1.78	1.9	10
Temperature, C	3.00	5.25	7.00	8.25	12.75	14.00	4.35	4.08	7.50	10
pH	7.85	8.03	8.21	8.23	8.42	8.63	0.39	0.534	0.39	3
Specific Conductance, µSiemens	799.00	859.	935.00	931.90	1005.	1061.00	101.06	114.16	146.00	7
Turbidity, NTU	6.52	103.3	200.0	138.8	205.0	210.0	114.7	14.83	101.7	3
Total Phosphorus, mg/L	0.08	0.16	0.221	0.2517	0.343	0.451	0.1178	0.106	0.1827	14
Total Nitrogen, mg/L	1.8200	1.82	1.8200	1.8200	1.82	1.82	0.0	0.0	0.0	2
Suspended Solids, mg/L	7.000	16.0	59.0	103.2	138.0	396.0	118.7	66.7	122.0	13
Dissolved Phosphorus, mg/L	0.05	0.05	0.05	0.05	0.05	0.05	-	0.0	0.0	1
Dissolved Nitrogen, mg/L	0.011	0.012	0.02	0.1237	0.043	1.21	0.342	0.0133	0.0315	12
Station: 4906130										
Dissolved Oxygen, mg/L	8.8	9.25	10.6	10.2	10.8	11.4	0.936	0.741	1.53	10
Temperature, C	1.50	4.00	6.50	7.18	11.25	13.50	4.25	4.60	7.25	10
pH	8.12	8.21	8.31	8.31	8.40	8.50	0.269	0.282	0.19	2
Specific Conductance, µSiemens	896.	1413.	1472.	1413.	1520.	1710.	274.6	89.7	107.	6
Turbidity, NTU	21.1	207.1	393.1	393.1	579.0	765.0	526.0	551.5	371.9	2
Total Phosphorus, mg/L	0.083	0.374	0.553	0.7536	1.022	1.79	0.5051	0.6005	0.648	13
Total Nitrogen, mg/L	2.1	2.1	2.1	2.1	2.1	2.1	-	0.0	0.0	1
Suspended Solids, mg/L	27.	143.	459.5	460.1	661.8	1067.	340.	437.	518.75	12
Dissolved Phosphorus, mg/L	0.032	0.032	0.032	0.032	0.032	0.032	-	0.0	0.0	1
Dissolved Nitrogen, mg/L	0.006	0.008	0.011	0.021	0.019	0.11	0.0288	0.0059	0.011	12
Station: 4906180										
Dissolved Oxygen, mg/L	7.4	8.45	10.0	9.9	11.6	12.0	1.73	2.52	3.1	10
Temperature, C	0.00	1.50	3.00	5.57	10.00	14.00	5.22	4.45	8.50	9
pH	8.53	8.54	8.54	8.54	8.54	8.55	0.0141	0.0148	0.01	2
Specific Conductance, µSiemens	303.	415.8	491.	469.2	544.5	577.	103.65	108.23	128.75	6
Turbidity, NTU	0.791	1.631	2.471	2.471	3.31	4.15	2.375	2.49	1.680	2
Total Phosphorus, mg/L	0.041	0.06	0.066	0.075	0.098	0.119	0.02531	0.02965	0.038	13
Total Nitrogen, mg/L	1.28	1.28	1.28	1.28	1.28	1.28	-	0.0	0.0	1
Suspended Solids, mg/L	0.000	0.750	4.5	6.66	10.0	28.0	8.15	6.67	9.25	12
Dissolved Phosphorus, mg/L	0.043	0.043	0.043	0.043	0.043	0.043	-	0.0	0.0	1
Dissolved Nitrogen, mg/L	0.001	0.003	0.004	0.0038	0.004	0.007	0.0017	0.00148	0.0015	11

7.2.3 ONEIDA RESERVOIR

Monitoring in Oneida Reservoir was carried out at four locations along the longitudinal axis of the reservoir (Figure E7-6) roughly in the inlet region (station OR1, up to 5 m deep), in two progressively deeper regions (OR2, 10 m deep, OR3, 17 m deep), and the deepest location near the dam (OR4, 22 m deep). At each of the locations, water quality observations were obtained at 1-meter intervals with depth. Samples for lab analysis were obtained at a larger depth interval that varied between sampling dates. These data are summarized in Figures E7-7 and E7-8 and in Table E7-7. The primary purpose of the profile measurements is to track the formation and breakdown of the thermocline and study the water quality at the surface (epilimnion), within the thermocline (metalimnion), and near the bottom (hypolimion) of the reservoir. The profiles were started in May 2009 and continued through November 2009 after the thermocline disappeared and just before ice started forming on the surface. Additional measurements were made through the ice in January and in early April just after ice breakup to study the water column during winter and early spring. Profiles were obtained approximately every two weeks with every other sampling event consisting of three separate profiles at each of the four sampling stations. Additional summaries and discussion of other water quality constituents are found in the Study 5 report (Stevens & Milleson, 2013).

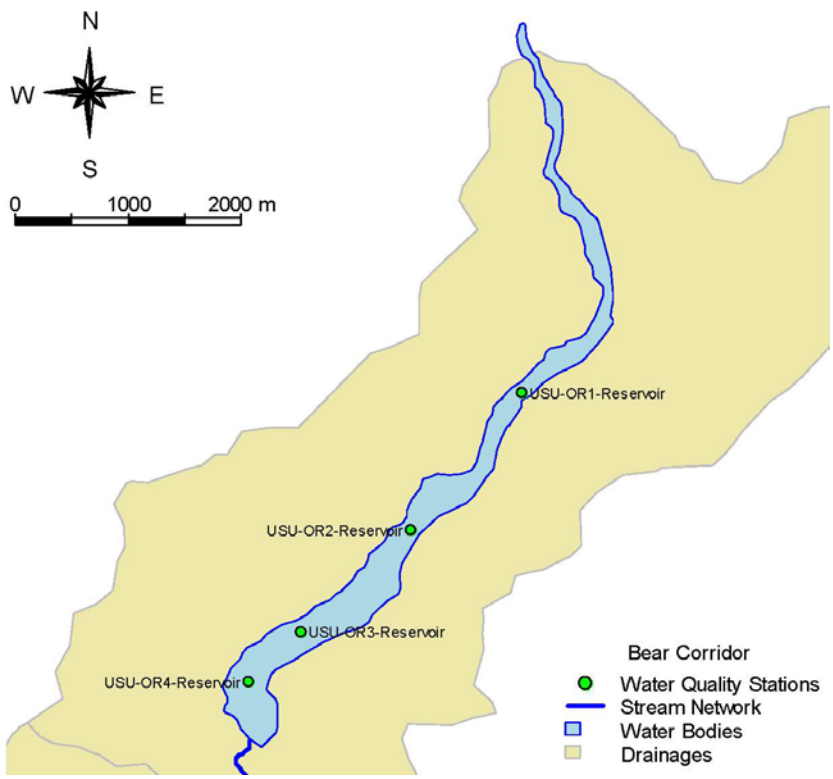


Figure E7-6. Location of water quality stations in Oneida Reservoir, 2009 – 2010.

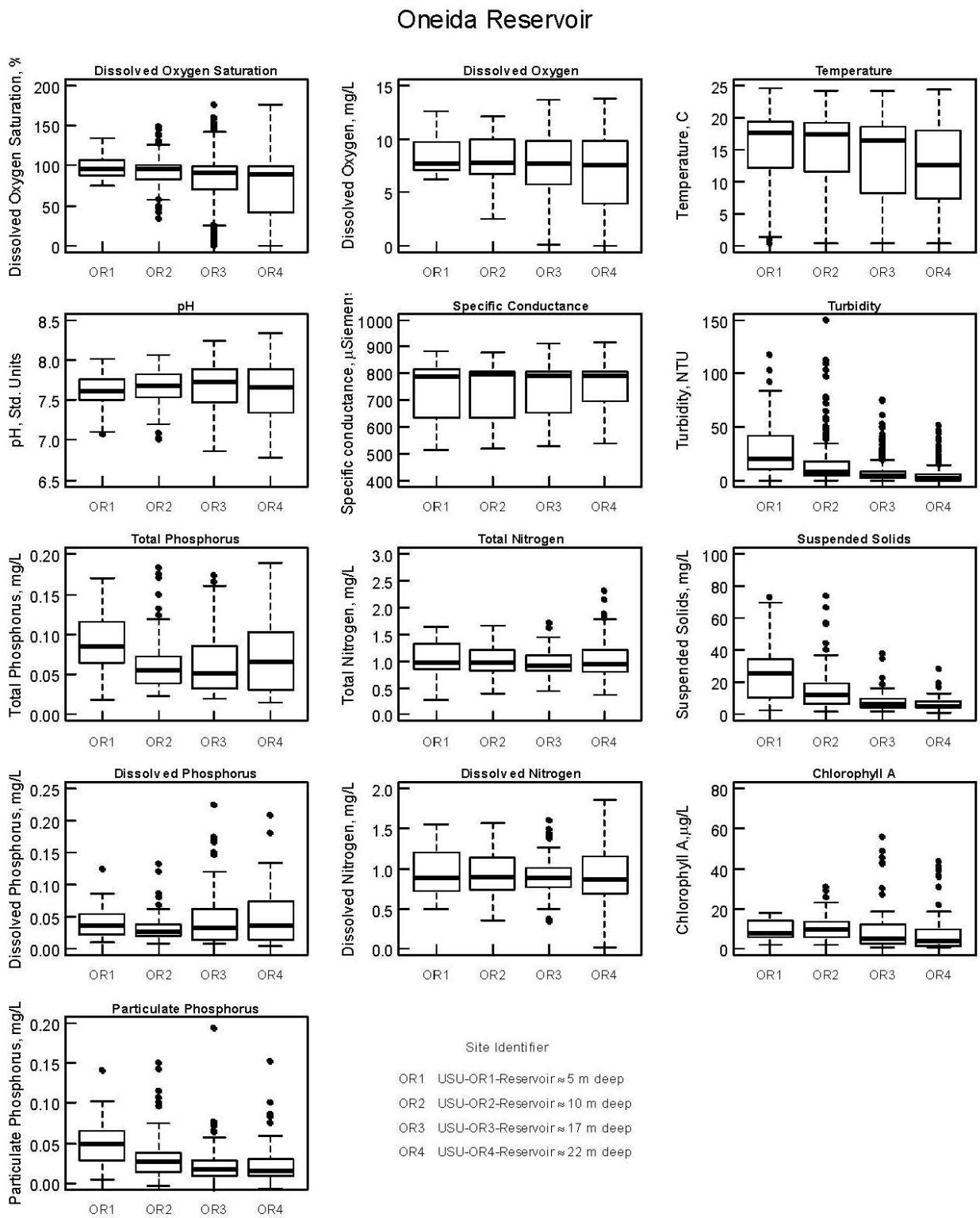


Figure E7-7. Summary box-whisker plots for Oneida Reservoir stations.

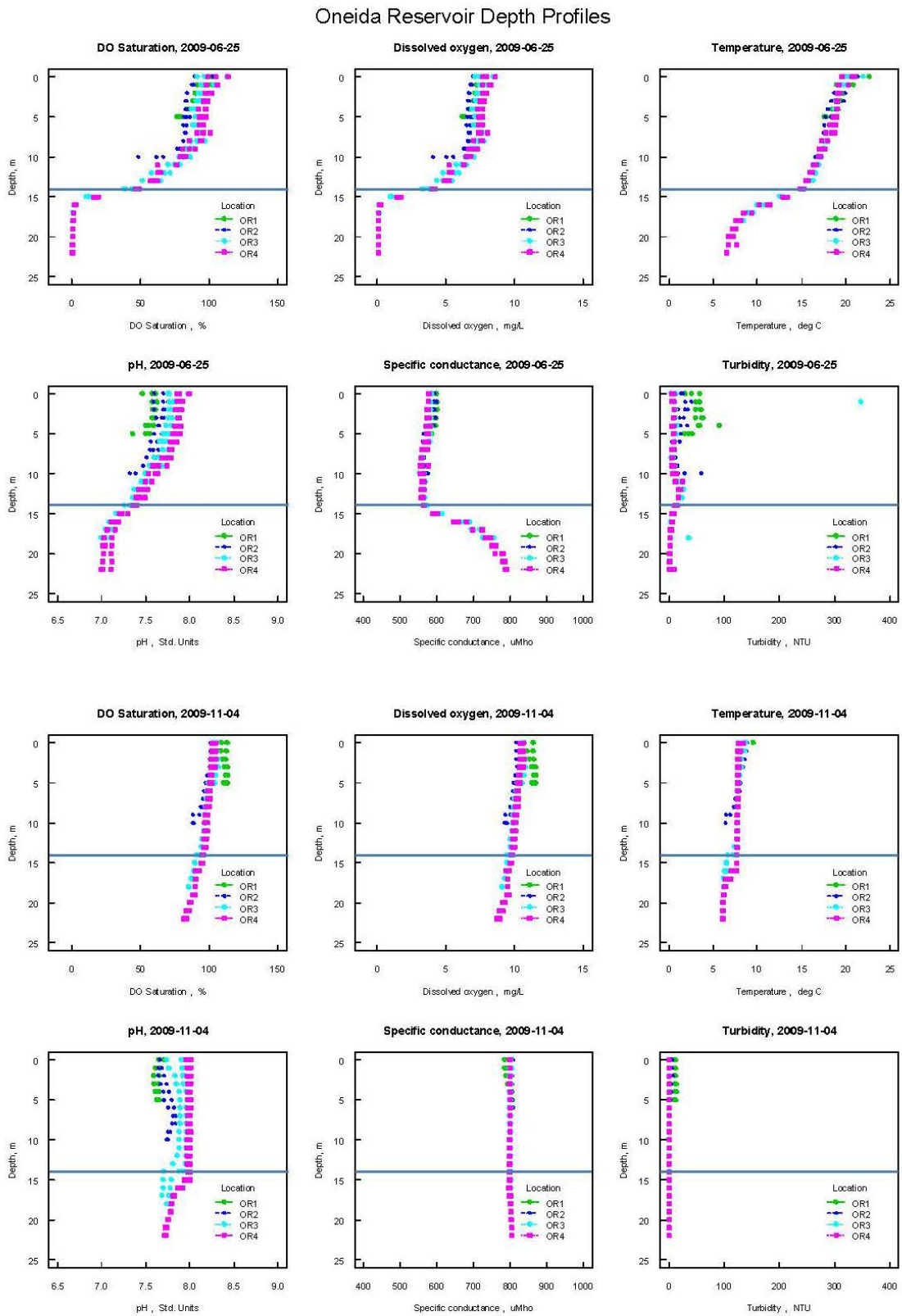


Figure E7-8. Depth profile plots for Oneida Reservoir stations, June 25, 2009 (upper) and November 10, 2009 (lower).

Table E7-7. Water quality data summaries – Oneida Reservoir Stations, 2009.

Station	Minimum	1st Qu.	Median	Mean	3rd Qu.	Maximum	Standard Deviation	Median Abs. Dev.[5]	IQR	Count
All Sites										
Dissolved Oxygen, mg/L	0.05	6.21	7.69	7.29	9.85	13.83	3.25	2.95	3.64	1633
Temperature, C	0.39	7.79	16.17	14.13	18.54	24.60	5.93	6.96	10.75	1636
pH	6.78	7.44	7.68	7.64	7.87	8.34	0.293	0.311	0.43	1637
Specific Conductance, µSiemens	514.5	654.3	791.5	741.7	806.1	917.5	94.76	66.42	151.8	1637
Turbidity, NTU	0.0	1.1	4.5	9.361	10.3	348.0	16.46	6.375	9.2	1633
Total Phosphorus, mg/L	0.0151	0.0368	0.0603	0.08965	0.092	1.5024	0.1269	0.03766	0.05582	266
Total Nitrogen, mg/L	0.280	0.825	0.949	1.020	1.155	2.304	0.323	0.224	0.330	268
Suspended Solids, mg/L	1.0	4.8	8.3	12.95	13.6	73.6	13.47	5.782	8.8	224
Dissolved Phosphorus, mg/L	0.0033	0.0166	0.0308	0.05363	0.053	0.7053	0.0800	0.02461	0.0407	265
Dissolved Nitrogen, mg/L	0.0165	0.739	0.892	0.935	1.074	2.204	0.316	0.235	0.336	268
Chlorophyll A, µg/L										
Particulate Phosphorus, mg/L										
Site OR1										
Dissolved Oxygen	6.19	7.09	7.69	8.48	9.63	12.6	1.94	1.24	2.54	162
Temperature	0.43	12.13	17.53	15.63	19.40	24.60	5.84	3.97	7.27	161
pH	7.07	7.50	7.61	7.61	7.76	8.01	0.195	0.178	0.26	162
Specific Conductance	514.50	631.90	785.05	733.17	815.9	882.00	102.27	111.42	183.98	162
Turbidity	0.0	10.62	20.25	26.07	42.12	116.6	21.47	16.23	31.5	162
Total Phosphorus	0.0185	0.0653	0.0856	0.08967	0.116	0.2136	0.04032	0.04492	0.0506	41
Total Nitrogen	0.2795	0.8388	0.9603	1.0539	1.336	1.6475	0.3452	0.2203	0.4974	41
Suspended Solids	2.400	11.100	26.150	26.208	35.00	73.400	17.505	19.126	23.900	38
Dissolved Phosphorus	0.0098	0.0229	0.0366	0.04197	0.054	0.1239	0.02499	0.02357	0.031	41
Dissolved Nitrogen	0.5004	0.7197	0.8849	0.9542	1.195	1.5573	0.3107	0.2983	0.4750	41
Chlorophyll A	2.180	5.760	7.960	9.405	14.14	18.250	4.900	6.360	8.380	37
Particulate Phosphorus	0.0045	0.0288	0.0498	0.0477	0.065	0.140	0.0292	0.0299	0.0365	41
Site OR2										
Dissolved Oxygen	2.58	6.72	7.76	8.1	9.89	12.2	1.91	2.09	3.17	302
Temperature	0.41	11.66	17.46	15.60	19.12	24.17	5.74	4.38	7.46	302
pH	7.01	7.54	7.68	7.67	7.82	8.06	0.217	0.208	0.277	302
Specific Conductance	520.10	635.40	794.60	733.32	806.7	877.20	99.86	77.54	171.28	302
Turbidity	0.0	4.125	7.65	14.25	17.08	150.0	18.87	7.339	12.95	302
Total Phosphorus	0.0233	0.0393	0.0545	0.06787	0.073	0.2366	0.04602	0.0255	0.0334	67
Total Nitrogen	0.3844	0.8343	0.9658	1.0196	1.213	1.6611	0.3200	0.2043	0.3791	67
Suspended Solids	2.000	7.350	11.950	16.414	19.25	73.600	15.967	8.451	11.900	56
Dissolved Phosphorus	0.0081	0.0194	0.0265	0.03304	0.039	0.1323	0.02385	0.01290	0.01975	67
Dissolved Nitrogen	0.3499	0.7341	0.8999	0.9425	1.138	1.5748	0.2901	0.2474	0.4035	67
Chlorophyll A	2.140	5.650	9.610	11.225	13.28	30.920	7.709	5.916	7.630	55
Particulate Phosphorus	-0.0032	0.0143	0.0273	0.0348	0.039	0.151	0.0316	0.0181	0.0245	67
Site OR3										
Dissolved Oxygen	0.07	5.77	7.72	7.33	9.84	13.7	3.10	3.08	4.07	510
Temperature	0.39	8.15	16.45	14.46	18.57	24.13	5.70	6.12	10.42	512
pH	6.86	7.47	7.72	7.66	7.89	8.23	0.282	0.311	0.422	512
Specific Conductance	525.90	652.38	792.50	738.41	804.6	913.70	95.29	76.13	152.23	512
Turbidity	0.0	1.5	4.0	7.646	8.5	348.0	17.89	5.486	7.0	509
Total Phosphorus	0.0192	0.0326	0.0522	0.07419	0.085	0.368	0.06887	0.04003	0.05225	79
Total Nitrogen	0.4512	0.8187	0.9213	0.9683	1.100	1.7163	0.2362	0.1729	0.2808	80
Suspended Solids	1.800	4.500	6.800	8.645	9.900	37.900	6.468	3.410	5.400	65
Dissolved Phosphorus	0.0079	0.0142	0.0329	0.04923	0.062	0.2241	0.04635	0.03113	0.0479	79
Dissolved Nitrogen	0.3398	0.7755	0.8735	0.8943	1.013	1.5961	0.2357	0.1752	0.2370	80
Chlorophyll A	0.760	2.565	5.280	10.738	12.19	55.490	13.391	5.841	9.625	62
Particulate Phosphorus	-0.023	0.0099	0.0174	0.0247	0.029	0.222	0.0343	0.0125	0.0191	80
Site OR4										
Dissolved Oxygen	0.05	3.96	7.6	6.59	9.86	13.8	3.88	3.54	5.9	659
Temperature	0.42	7.40	12.52	12.84	17.95	24.33	5.93	7.65	10.55	661
pH	6.78	7.34	7.66	7.61	7.89	8.34	0.343	0.40	0.55	661
Specific Conductance	536.10	697.30	791.10	750.27	804.8	917.50	89.42	54.26	107.50	661
Turbidity	0.0	0.0	2.15	4.348	5.825	51.7	6.47	3.188	5.825	660
Total Phosphorus	0.0151	0.0307	0.0655	0.1236	0.104	1.502	0.2133	0.05634	0.0729	79
Total Nitrogen	0.3589	0.8075	0.9364	1.0540	1.207	2.3041	0.3824	0.2912	0.3994	80
Suspended Solids	1.000	4.300	5.200	6.528	8.200	28.500	4.280	2.076	3.900	65
Dissolved Phosphorus	0.0033	0.0151	0.0352	0.0819	0.073	0.7053	0.1330	0.03454	0.05827	78
Dissolved Nitrogen	0.0165	0.6838	0.8727	0.9610	1.149	2.2043	0.4010	0.3099	0.4652	80
Chlorophyll A	0.510	1.302	4.225	8.970	9.350	43.230	11.771	4.678	8.047	62
Particulate Phosphorus	-0.0344	0.0093	0.0159	125.0	0.031	9999.1	1117.9	0.0119	0.0217	80

7.2.4 STORM SAMPLING

Several storm events were sampled during 2009 to provide estimates of watershed loading resulting from surface runoff. Storm events were variously monitored at seven locations on April 14-15, 2009, October 14-15, 2009, and April 22-23, 2010. When a storm event was anticipated from National Weather Service forecasts, iced automated samplers were deployed for 24-36 hours at three to four of seven locations to collect water quality samples at 1 to 3 hour intervals. Selected results of the storm sampling events on April 14-15, 2009 for station BR1 (Bear River above Oneida reservoir) and October 14-15, 2009 for Mink Creek at Riverdale are displayed in Figure E7-9. Statistical summaries of all storm events are found in Table E7-8. Full results for all storm events are found in the Study 5 report (Stevens & Milleson, 2013).

The storm event sampling efforts during 2009 and 2010 clearly show that, for the Bear River monitoring stations (BR1, BR3, and BR6), the concentrations of phosphorus and nitrogen in their various forms in the Bear River remained constant throughout the 36-hour monitoring period. The one exception was at station BR6 (Bear River at Weston-Fairview Road near the Utah state line) on April 14-15, 2009, at which small increases in nutrients and a pulse of suspended solids were observed starting at approximately hour 12 of the event. The October storm event at BR6 showed no increase in any of the constituents.

The storm event response in the tributaries (Cottonwood Creek, Deep Creek, and Mink Creek) was somewhat more dynamic, particularly in the October storm event in Mink Creek. The storm event on April 21-22, 2010 that produced 0.7 – 1.4 mm precipitation, caused slight increases in the nutrient concentrations and suspended solids in Cottonwood Creek over 24 hours starting in the second hour of the event. Little or no increases in nutrients were observed in Deep Creek during the same event. On October 14-15, 2009, 2.6 – 6.5 mm of rain fell and produced large increases in the nutrient and suspended solids concentrations (see Figure E7-9). Though flows were not observed, model estimates of the flow at the Mink Creek confluence with the Bear River suggest that more than 60% of the total phosphorus load over the 36-hour event was contributed during the 6 hour peak, and the full impact of the storm event was felt for over 24 hours. The curves for total and particulate phosphorus closely mirrored the total suspended solids curve, and similar results were obtained for the other five constituents. Although the large event in October 2009 produced a large response in Mink Creek, storm monitoring during the same event on the Bear River just downstream of the Mink Creek confluence showed no change for any of the parameters monitored. Because the flow rate in the Bear River is so large, even the dramatic response shown in Mink Creek, the major tributary between Oneida Reservoir and the Cub River in Utah, was absorbed and lost in the noise.

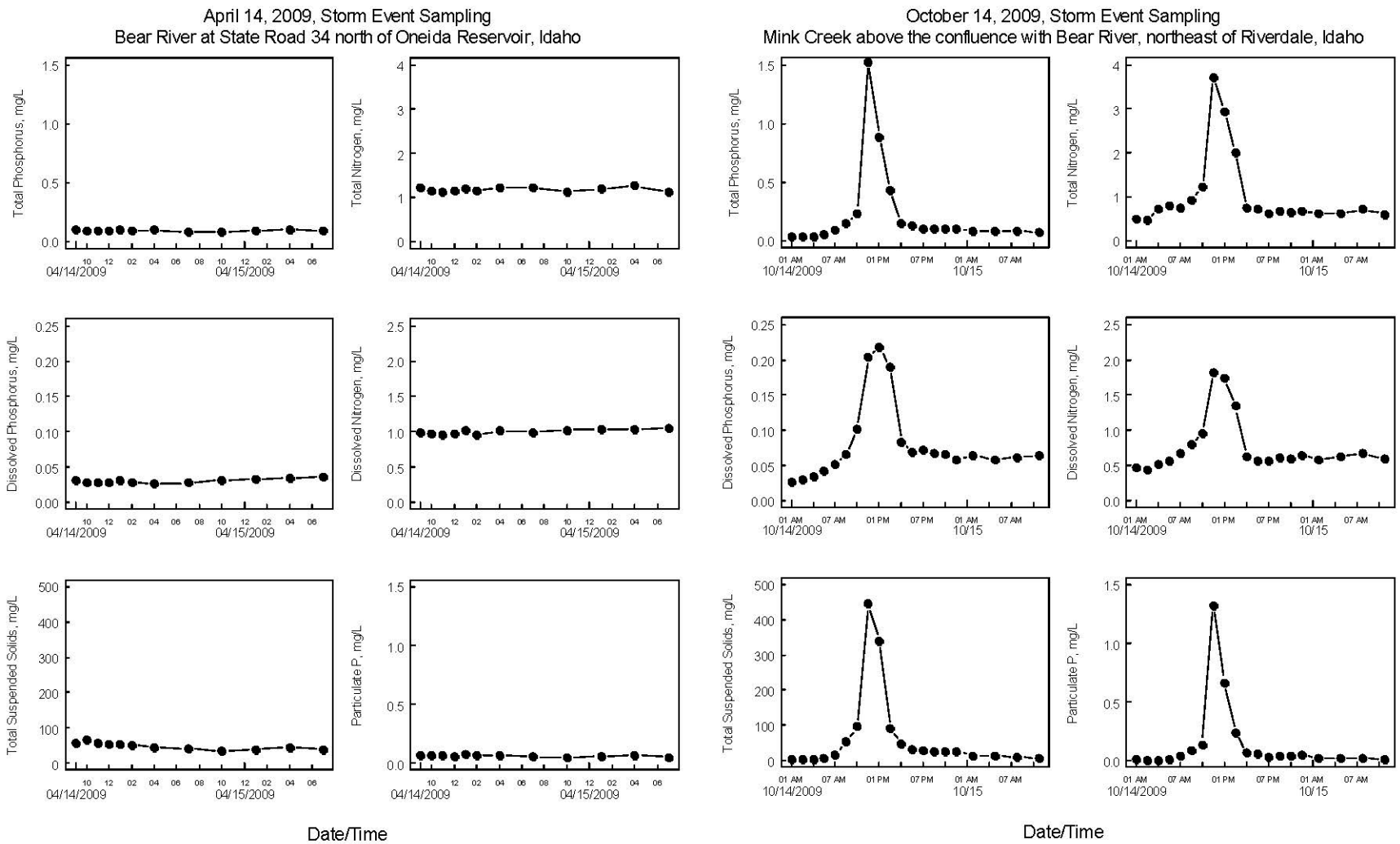


Figure E7-9. Example storm event monitoring time series - Bear River above Oneida Reservoir, April 14-15, 2009 (left side) and Mink Creek near Riverdale, October 14 -15, 2009 (right side).

Table E7-8. Water quality data summaries – storm event sampling.

Station	Minimum	1st Qu.	Median	Mean	3rd Qu.	Maximum	Standard Deviation	Median Absolute Deviation[h]	Inter-quartile Range	Count
Site: BR1 – April 14-15, 2009										
Total Phosphorus, mg/L	0.0785	0.090	0.0927	0.0928	0.098	0.104	0.0078	0.00764	0.00802	12
Total Nitrogen, mg/L	1.12	1.14	1.17	1.18	1.22	1.26	0.0485	0.0607	0.0803	12
Dissolved Phosphorus, mg/L	0.0258	0.028	0.0298	0.0304	0.032	0.036	0.00309	0.00267	0.00375	12
Dissolved Nitrogen, mg/L	0.952	0.973	1.00	1.00	1.03	1.05	0.0347	0.0454	0.057	12
Suspended Solids, mg/L	34.5	41.0	48.75	48.67	55.38	65.0	9.262	11.12	14.38	12
Particulate Phosphorus, mg/L	0.0471	0.058	0.0643	0.0624	0.068	0.0725	0.00818	0.007635	0.01005	12
Site: BR3 – April 14-15, 2009										
Total Phosphorus, mg/L	0.0392	0.042	0.0461	0.0457	0.049	0.0514	0.00412	0.00578	0.00683	12
Total Nitrogen, mg/L	0.954	0.975	0.988	0.994	1.01	1.08	0.0355	0.0294	0.0324	12
Dissolved Phosphorus, mg/L	0.0194	0.021	0.0226	0.0228	0.024	0.0307	0.00290	0.00193	0.00258	12
Dissolved Nitrogen, mg/L	0.878	0.93	0.947	0.945	0.968	1.01	0.0358	0.0328	0.0378	12
Suspended Solids, mg/L	8.0	8.475	9.2	9.642	10.12	14.4	1.834	1.186	1.65	12
Particulate Phosphorus, mg/L	0.0198	0.021	0.0224	0.0230	0.024	0.0287	0.002738	0.002595	0.003675	12
Site: BR4 – April 14-15, 2009										
Total Phosphorus, mg/L	0.0645	0.069	0.082	0.0986	0.13	0.15	0.034	0.0235	0.0614	18
Total Nitrogen, mg/L	1.01	1.07	1.16	1.18	1.26	1.42	0.128	0.149	0.196	18
Dissolved Phosphorus, mg/L	0.021	0.023	0.0248	0.0287	0.037	0.0418	0.0076	0.00474	0.0140	18
Dissolved Nitrogen, mg/L	0.908	0.969	0.99	1.01	1.06	1.17	0.0724	0.0444	0.0893	18
Suspended Solids, mg/L	36.0	39.75	57.65	73.68	116.3	126.3	37.25	30.99	76.55	18
Particulate Phosphorus, mg/L	0.0424	0.045	0.05575	0.0699	0.101	0.1101	0.02782	0.01898	0.05562	18
Site: BR6 – April 14-15, 2009										
Total Phosphorus, mg/L	0.0341	0.050	0.0644	0.0703	0.081	0.136	0.0286	0.0234	0.0312	19
Total Nitrogen, mg/L	0.811	0.944	1.00	1.00	1.06	1.15	0.0978	0.0973	0.121	19
Dissolved Phosphorus, mg/L	0.0153	0.018	0.0267	0.0239	0.028	0.0309	0.00541	0.00341	0.00955	19
Dissolved Nitrogen, mg/L	0.722	0.798	0.88	0.849	0.892	0.968	0.0675	0.0506	0.0941	19
Suspended Solids, mg/L	15.0	38.0	73.4	73.11	95.75	150.0	42.4	51.0	57.75	19
Particulate Phosphorus, mg/L	0.0175	0.029	0.0386	0.0464	0.052	0.1088	0.02586	0.01661	0.0228	19
Site: Cottonwood Creek – April 14-15, 2009										
Total Phosphorus, mg/L	0.0496	0.079	0.085	0.100	0.113	0.174	0.0469	0.0418	0.034	5
Total Nitrogen, mg/L	0.456	0.612	0.63	0.66	0.693	0.906	0.163	0.0924	0.0807	5
Dissolved Phosphorus, mg/L	0.0237	0.027	0.0317	0.0348	0.034	0.0575	0.0133	0.00712	0.0072	5
Dissolved Nitrogen, mg/L	0.372	0.372	0.393	0.411	0.457	0.461	0.0445	0.0307	0.0847	5
Suspended Solids, mg/L	51.5	80.0	141.4	121.6	155.0	180.0	53.77	57.23	75.0	5
Particulate Phosphorus, mg/L	0.0259	0.052	0.0533	0.0653	0.056	0.1395	0.04319	0.003558	0.0034	5
Site: Deep Creek – April 14-15, 2009										
Total Phosphorus, mg/L	0.159	0.163	0.195	0.198	0.234	0.247	0.0346	0.0504	0.0708	9
Total Nitrogen, mg/L	1.87	1.98	2.03	2.05	2.09	2.21	0.111	0.083	0.107	9
Dissolved Phosphorus, mg/L	0.0548	0.059	0.0624	0.0606	0.063	0.067	0.00390	0.0043	0.0038	9
Dissolved Nitrogen, mg/L	1.66	1.70	1.81	1.81	1.87	2.00	0.125	0.159	0.171	9
Suspended Solids, mg/L	100.0	120.3	121.5	136.0	160.6	166.9	25.28	31.88	40.3	9
Particulate Phosphorus, mg/L	0.1004	0.106	0.1328	0.1374	0.174	0.18	0.03198	0.04300	0.0676	9
Site: Mink Creek, April 22-23, 2010										
Total Phosphorus, mg/L	0.0762	0.076	0.0852	0.087	0.097	0.102	0.0107	0.0133	0.0206	8
Total Nitrogen, mg/L	0.637	0.72	0.763	0.772	0.831	0.90	0.0845	0.0826	0.112	8
Dissolved Phosphorus, mg/L	0.0462	0.049	0.0524	0.0524	0.055	0.0595	0.00449	0.00437	0.00602	8
Dissolved Nitrogen, mg/L	0.591	0.603	0.658	0.668	0.709	0.81	0.0765	0.0842	0.106	8
Suspended Solids, mg/L	19.6	24.9	28.1	29.95	32.82	45.7	8.879	6.523	7.925	8
Particulate Phosphorus, mg/L	0.0219	0.026	0.0298	0.0346	0.043	0.0523	0.01140	0.008525	0.01717	8

(con't) Station	Minimum	1st Qu.	Median	Mean	3rd Qu.	Maximum	Standard Deviation	Median Absolute Deviation[i]	Inter-quartile Range	Count
Site: BR4, October 14-15, 2009										
Total Phosphorus, mg/L	0.0115	0.014	0.0163	0.0159	0.018	0.0207	0.00284	0.00363	0.00402	10
Total Nitrogen, mg/L	0.555	0.648	0.698	0.701	0.773	0.794	0.0799	0.10	0.125	10
Dissolved Phosphorus, mg/L	0.0026	0.007	0.00885	0.0082	0.009	0.012	0.00249	0.00111	0.0023	10
Dissolved Nitrogen, mg/L	0.553	0.62	0.695	0.688	0.747	0.799	0.0837	0.110	0.127	10
Suspended Solids, mg/L	1.6	2.05	2.45	2.74	2.975	4.5	1.027	0.7413	0.925	10
Particulate Phosphorus, mg/L	0.0047	0.005	0.0073	0.0078	0.010	0.0116	0.002603	0.003781	0.004475	10
Site: BR6, October 14-15, 2009										
Total Phosphorus, mg/L	0.0117	0.015	0.0155	0.0158	0.016	0.0261	0.00392	0.00111	0.0014	10
Total Nitrogen, mg/L	0.625	0.691	0.707	0.721	0.726	0.954	0.09	0.0305	0.0352	10
Dissolved Phosphorus, mg/L	0.006	0.007	0.00725	0.0077	0.008	0.0118	0.00178	0.00126	0.0016	10
Dissolved Nitrogen, mg/L	0.587	0.618	0.667	0.66	0.70	0.718	0.05	0.0656	0.0826	10
Suspended Solids, mg/L	4.0	4.6	4.9	5.12	6.0	6.2	0.86	1.334	1.4	10
Particulate Phosphorus, mg/L	0	0.006	0.0077	0.0081	0.009	0.0201	0.00505	0.002298	0.00295	10
Site: Mink Creek, October 14-15, 2009										
Total Phosphorus, mg/L	0.0321	0.078	0.0987	0.223	0.146	1.53	0.362	0.0574	0.0684	20
Total Nitrogen, mg/L	0.458	0.63	0.714	1.03	0.828	3.71	0.86	0.130	0.198	20
Dissolved Phosphorus, mg/L	0.0272	0.057	0.0646	0.0813	0.075	0.218	0.0559	0.0153	0.0183	20
Dissolved Nitrogen, mg/L	0.434	0.569	0.621	0.77	0.707	1.83	0.398	0.082	0.138	20
Suspended Solids, mg/L	3.0	8.5	26.25	64.5	49.15	445.0	116.5	29.73	40.65	20
Particulate Phosphorus, mg/L	0.0021	0.017	0.03485	0.1419	0.068	1.321	0.3147	0.03669	0.0509	20

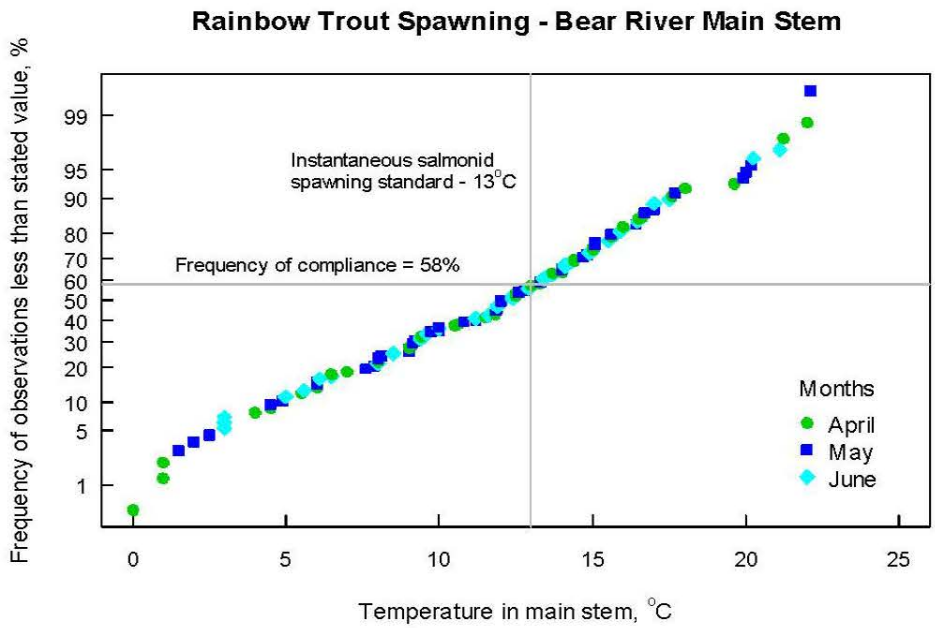
7.2.5 SUMMARY OF EXISTING WATER QUALITY CONDITIONS

The purposes of the water quality monitoring program were to confirm the consistency of the conditions during the study period with historical observations, and to support water quality modeling and fish habitat assessment. The complete water quality data set collected under Study 5 includes data collected for the Bear River mainstem, six tributaries, four locations in Oneida Reservoir and storm sampling on the Bear River and several tributaries. Summaries and assessments for each of the major water quality monitoring efforts are provided below. A presentation of all data and additional discussion may be found in the Study 5 report (Stevens & Milleson, 2013).

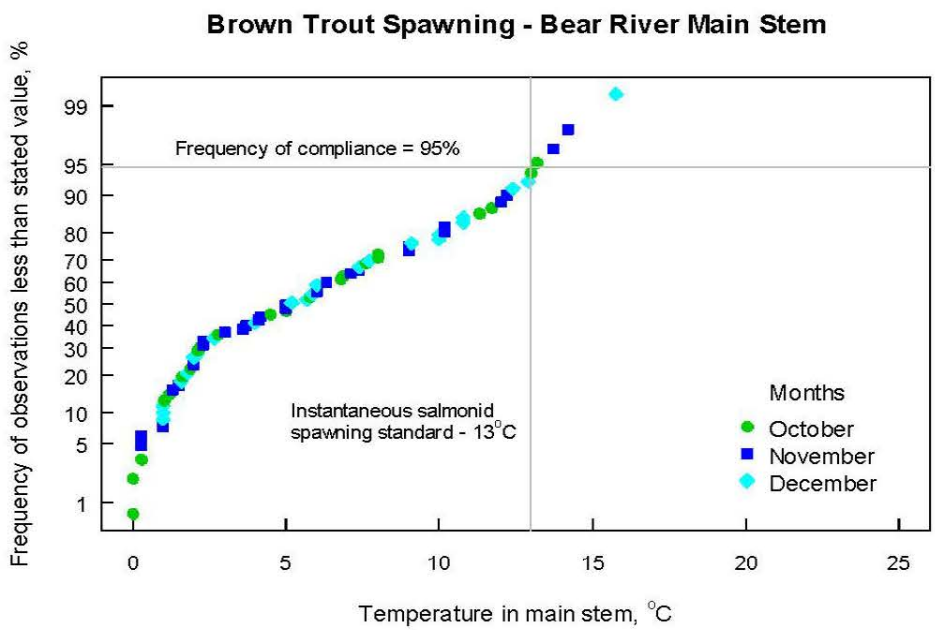
7.2.5.1 Bear River Mainstem

Results of the 2009 – 2010 mainstem Bear River monitoring effort were consistent with historical observations for all constituents, with one exception: at station BR5 dissolved oxygen measured during 2009 - 2010 was consistently higher than in the historical database. Overall dissolved oxygen concentrations during the study period were consistently above the water quality standard of 6 mg/L, even downstream of Oneida Dam (Stations BR2 and BR3) where the water quality standards are relaxed. Temperature observations were generally in compliance with the standards for cold water aquatic life requiring temperature to be ≤22°C with ≤19°C for a daily average. One observation during the study period at station BR6 (near the ID/UT border) was in excess of the standard at 22.8°C, well downstream of the proposed Narrows dam. The frequency of temperature compliance for salmonid spawning (≤13°C instantaneous and ≤9°C daily average during spawning season) in the Bear River mainstem was 58% of the observations for rainbow and cutthroat trout and 96% of the observations for brown trout (see Figure E7-10).

Observations of pH ranged from 6.7 to 8.9 during the study and complied with the standard of 6.5 to 9. Total suspended solids (TSS) ranged from 2 to 97 mg/L during the study period, with the extreme value observed at stations BR1 (above Oneida Dam) and BR5 (Bear River at Highway 91 crossing) where peak values of 97 mg/L and 61 mg/L, respectively were recorded. State water quality standards dictate TSS values ≤60 mg/L during base flow and ≤ 90 mg/L during spring runoff. The concentration of 97 mg/L at BR1 occurred in June, exceeding the standard, and the concentration of 61 mg/L at BR6 occurred in May, during the spring runoff period. The water quality standard for turbidity is more complicated, stating that the turbidity is to be ≤50 NTU above background for instantaneous readings and ≤25 NTU above background for 10 days. If background is defined as the turbidity at the 25th percentile of all mainstem observations, 5 NTU, the standard becomes ≤55 NTU for instantaneous observations. Overall, the turbidity in the Bear River mainstem exceeded this standard less than 5% of the time, with one exceedance at station BR1 and four at station BR6, all during the period from January through June.



a) Rainbow trout



b) Brown Trout

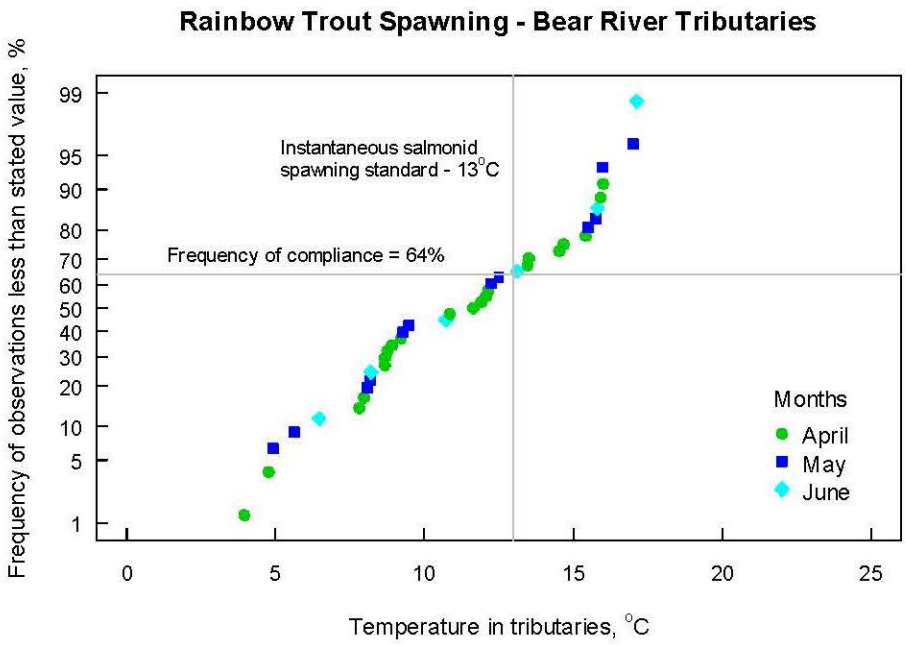
Figure E7-10. Frequency plots for compliance of Historical Observations and 2009 Study Observations for salmonid spawning a) rainbow trout, and b) brown trout - Bear River mainstem.

Total phosphorus concentrations exceeded the Idaho water quality criterion for rivers of 0.075 mg/L in 18% of the observations overall, with the exceedances distributed across all stations except BR4 on the Bear River mainstem. The station with the most exceedances was BR1, just upstream of Oneida Reservoir, which exceeded state criterion in 5 out of 18 (28%) of the samples. The secondary target of 0.05 mg/L total phosphorus for rivers flowing into reservoirs at the ID/UT state line (Station BR6) is exceeded in 25% of the observations (4 out of 16).

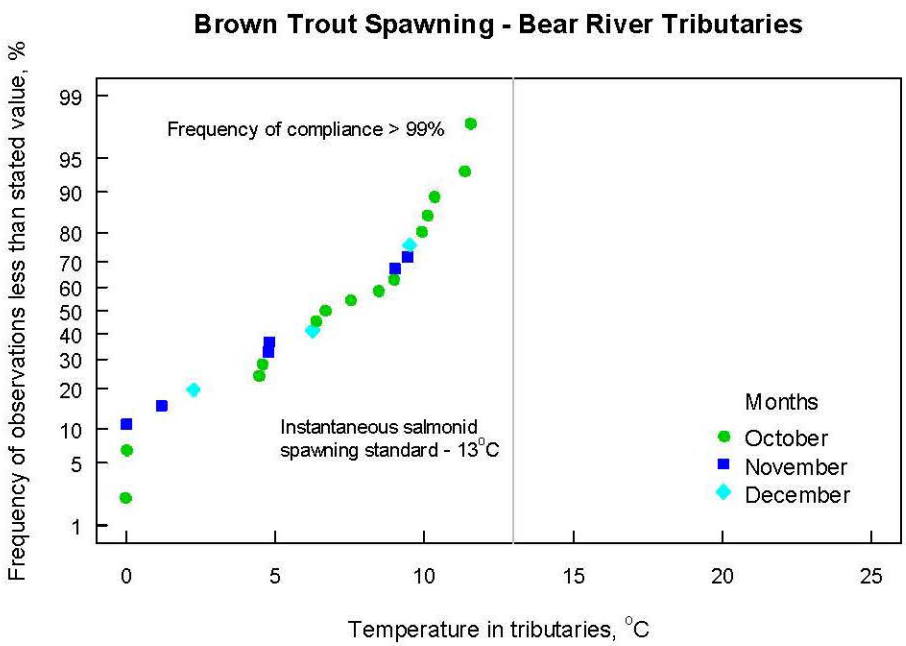
7.2.5.2 Bear River Tributaries

Results of the 2009 – 2010 Bear River tributary monitoring effort were consistent with historical observations for all constituents, with some exceptions. For example, dissolved oxygen at station SC, Station Creek, was consistently higher than in the historical database. Other variations from historical observations were small and are documented in the Study 5 report (Stevens & Milleson, 2013). With the exception of turbidity and total phosphorus, these new data demonstrate that the Bear River tributaries monitored through the project reach are generally in compliance with the State of Idaho standards. Dissolved oxygen concentrations during the study period were consistently above the water quality standard of 6 mg/L in all tributaries with results ranging from 8.3 to 13 mg/L. Temperature observations were generally in compliance with the standards for cold water aquatic life requiring temperature to be ≤22°C with ≤19°C for a daily average. The frequency of temperature compliance for salmonid spawning (≤13°C instantaneous and ≤9°C daily average during spawning season) in the Bear River tributaries was 64% of the observations for rainbow and cutthroat trout and 99% of the observations for brown trout (see Figure E7-11).

Observations of pH ranged from 7.5 to 9 during the study and complied with the standard of 6.5 to 9. Total suspended solids (TSS) ranged from 1 to 800 mg/L during the study period, with extreme values observed at all stations except Cottonwood Creek. State water quality standards dictate TSS values ≤60 mg/L during base flow and ≤90 mg/L during spring runoff. Total suspended solids concentrations exceeded the standard throughout the year in the tributaries monitored, peaking during the spring runoff period. For turbidity, if background is defined as the turbidity at the 25th percentile of all tributary observations, 6.5 NTU, the standard becomes ≤56.5 NTU for instantaneous observations. Overall, the turbidity in the Bear River tributaries exceeded this standard slightly less than 50% of the time, with Battle Creek exceeding the standard in all samples.



a) Rainbow trout



b) Brown Trout

Figure E7-11. Frequency plots for compliance of Historical Observations and 2009 Study Observations for salmonid spawning a) rainbow trout, and b) brown trout - Bear River Tributaries.

Total phosphorus concentrations in the Bear River tributaries exceeded the Idaho water quality criterion for rivers of 0.075 mg/L in more than 65% of the observations overall, with the exceedances distributed across all stations except Cottonwood Creek, which was in compliance with the total phosphorus standard, and Mink Creek which was in compliance in more than 50% of the observations. One station, Deep Creek, exceeded state standards with all observations.

7.2.5.3 Oneida Reservoir

During the 2009 – 2010 study program, stratification had begun by May 7 and was fully established by June 11 when a strong thermocline had formed. Oneida remained strongly stratified until late September when mixing began. The reservoir was essentially fully mixed by November 4.

Results of the 2009 – 2010 Oneida Reservoir monitoring effort were not compared with historical data because historical data were not found for this water body; however, the new water quality observations compare favorably with other reservoirs in the intermountain region (Stevens, Miner, Hardy, & Eggleston, 1999). With the exception of temperature and total phosphorus, these data demonstrated that water quality in Oneida Reservoir were generally in compliance with the State of Idaho standards. Dissolved oxygen concentrations in Oneida Reservoir during the study period were consistently above the water quality standard of 6 mg/L in waters above 10 m deep with results ranging from 6 to 14 mg/L. Below the hypolimnion, dissolved oxygen dropped to near zero during stratification, especially at stations OR3 and OR4, in the downstream portions of the reservoir where water depth exceeds 20 m. Temperature observations were generally in compliance with the standards for cold water aquatic life requiring temperature to be ≤22°C with ≤19°C for a daily average, with the exception of water in the surface layers that approached 25°C during July and August.

Observations of pH ranged from 6.8 to 7.3 during the study and complied with the standard of 6.5 to 9. Total suspended solids (TSS) ranged from 1 to 74 mg/L during the study period, with extreme values observed at the upstream stations OR1 and OR2, reflecting the influence of the incoming Bear River. Downstream stations had decreasing suspended solids. State water quality standards dictate TSS values ≤60 mg/L during base flow and ≤90 mg/L during spring runoff. The total suspended solids concentration exceeding the standard occurred during the spring runoff period. Since there is no turbidity standard for reservoirs, an informal comparison can be made using standards for cold water aquatic life. If background is defined as the turbidity at the 25th percentile of all reservoir observations, 1 NTU, the standard becomes ≤51 NTU for instantaneous observations. Overall, the turbidity in the Oneida Reservoir exceeded this informal standard slightly less than 1% of the time; however high turbidities were observed, infrequently, at all stations except OR4, near the dam.

Total phosphorus concentrations exceeded the Idaho water quality criterion for rivers of 0.075 mg/L in more than 65% of the observations overall, with the exceedances distributed across all locations in the reservoir. Station OR2 had slightly lower total phosphorus concentrations than the others, but still exceeded the standard in more than 20% of the samples. Dissolved phosphorus, often regarded as an improved measure of biologically available phosphorus for algae growth, averaged about 50% of the total phosphorus over all stations, with stations closer to the dam

showing higher dissolved fractions. Chlorophyll *a*, for which there is no water quality standard but is regarded as a measure of the productivity of a reservoir, averaged approximately 10 µg/L throughout the study but was highly variable in time and space. Chlorophyll *a* generally increased as the water moved toward the dam and ranged from 0.5 to 56 µg/L at stations OR3 and OR4. The higher values of chlorophyll *a* coupled with the high total phosphorus and turbidity, places Oneida Reservoir well into the eutrophic region for its trophic status.

7.2.5.4 Overall Summary of Existing Water Quality Conditions

The combination of historic data with the data from the current study demonstrate that the water quality in the Bear River, its tributaries, and Oneida Reservoir, is consistent with snow-melt driven watersheds in the intermountain region with natural phosphorus deposits and agricultural inputs. Although generally compliant with State of Idaho Water Quality Standards and Criteria, this system is enriched with nutrients, particularly phosphorus. Though phosphorus represents little in the way of toxicity to humans or the environment, the effects of enriched nutrients on reservoirs and downstream receiving waters are well known and primarily have to do with excessive growth of plants: phytoplankton, periphyton, and macrophytes. These effects can cause nuisance conditions for drinking water supplies (primarily taste and odor) but, in some cases, the shortage of nitrogen relative to phosphorus promotes the growth of nitrogen-fixing cyanobacteria (previously known as blue-green algae) that can produce chemical compounds that are toxic to humans, livestock, and fish. The overproduction of algae can also cause large amplitude fluctuations in dissolved oxygen in rivers during summer that can produce conditions detrimental to fish habitat, particularly for salmonids and other cold water fish. In addition, low dissolved oxygen in waters released from the hypolimnion in reservoirs can interfere with habitat for fish living near the release points of dams. The effects of low oxygen releases in high gradient rivers such as the Bear River persist for short distances downstream because of the re-aeration that takes place in turbulent conditions.

Of major concern for the propose project is the impact of water quality on the suitability of the Bear River for cold water aquatic life and for salmonid spawning, primarily related to temperature. The water quality standard for temperature that applies to the Bear River for cold water aquatic life requires that temperature must be ≤22°C for instantaneous measurement and ≤19°C for maximum daily average. The full data set, combining data from this study and from the historical database showed compliance with this standard for the large majority of observations. The compliance of the system for salmonid spawning was dependent on salmonid species. For rainbow and cutthroat trout, which spawn in the spring, both the Bear River mainstem and its tributaries had approximately the same degree of compliance: 58% for the mainstem and 64% for the tributaries. The situation is improved for brown trout, with compliance of 96% and >99% for the mainstem and tributaries, respectively.

7.3 Project Effects on Water Quality in Bear River

The assessment of the potential effects of the proposed project on water quality was based on building, populating, calibrating, testing, and executing mathematical models of the Bear River system from Oneida Dam to the Utah/Idaho border under current conditions and under conditions expected if the Narrows Dam was constructed. The Study 5 report contains detailed information

concerning model structure, calibration, and testing (Stevens & Milleson, 2013)[1]. This section discusses the model-predicted impacts of the proposed project on stream water quality below the Narrows Dam and on the ability of the river to meet its beneficial uses.

The calibrated model was used to simulate 20 years of flows and water quality in the Bear River below Oneida under three scenarios designed to estimate the impact of the proposed Oneida Narrows Reservoir (ONR) on downstream habitat and water quality. One scenario, designated as the "Base Case", simulates existing conditions with water released from Oneida Dam and flowing in the Bear River without the ONR. The Base Case does not model any water quality impacts that may take place in the PacifiCorp Oneida powerhouse, such as re-aeration. The other two scenarios simulate the presence of the ONR under two alternative operating regimes: the "Narrows Case", which simulates run-of-reservoir operations with the reservoir water level maintained at a constant elevation of 4,734 ft ASL, and the "Drawdown Case", which simulates drawdown and refilling of the reservoir to supply supplemental irrigation water[2]. Water quality impacts were assessed by examining differences in key water quality parameters at downstream locations for the two ONR models in comparison with the Base Case model. Results for all modeled water quality parameters are summarized in Table E7-9 for node 17 immediately below the new proposed reservoir and in Table E7-10 for node 8 at the UT/ID border. Figure E7-12 shows graphs of the predicted project-induced changes to selected water quality parameters at nodes 17 and 8. Figures E7-13 to E7-24 show full results for these same selected parameters under all three simulation scenarios. Key modeling results for temperature, dissolved oxygen and nutrients are discussed in the following sections.

[1] The Study 5 Report has been significantly revised since the Draft License Application was issued in 2011. The water quality information presented in this Final License Application is based on the revised Study 5 report issued in 2013.

[2] The frequency and amount of drawdown and refilling was based on actual water shortages experienced by Twin Lakes from 1990 to 2010 as detailed in Appendix D

Table E7-9. Summary statistics comparing key water quality characteristics for the Narrows vs. Base Case scenarios (upper table) and Drawdown vs. Base Case scenarios (lower table) at Node 17, Bear River below Oneida Narrows Reservoir.

Constituent	Minimum	25%	Median	Mean	75%	Maximum
Compare Narrows Base Case to Oneida Base Case						
Flow, ft^3/s	-123.8	-2.9	-0.41	-2.39	2.41	188.1
Temperature, °C	-5.276	-0.9390	-0.27	-0.53430	0.025	4.919
Dissolved oxygen, mg/L	-1.862	-0.4760	0.23	0.22880	0.846	2.450
Specific conductance, µSiemens	-138.7	16.0	50	65.5	93.3	464.2
Chlorophyll a, µg/L	-7.059	-0.1100	0.98	2.89400	6.076	16.870
Total Phosphorus, mg/L	-0.024	-0.0083	-0.00001	0.00031	0.006	0.087
Total Nitrogen, mg/L	-0.320	0.1799	0.28	0.30240	0.370	2.200
Compare Narrows Drawdown Case to Oneida Base Case						
Flow, ft^3/s	--123.8	-2.9	-0.094	1.42	4.60	188.1
Temperature, °C	-5.514	-0.9360	-0.27	-0.53840	0.024	4.911
Dissolved oxygen, mg/L	-1.868	-0.4600	0.22	0.23040	0.839	2.451
Specific conductance, µSiemens	-138.6	16.1	51	65.37	92.9	464.
Chlorophyll a, µg/L	-7.049	-0.128	0.98	2.906	6.088	16.88
Total Phosphorus, mg/L	-0.024	-0.0083	-.000012	0.00033	0.006	0.086
Total Nitrogen, mg/L	-0.320	0.1799	0.27	0.3041	0.371	2.18

Table E7-10. Summary statistics comparing key water quality characteristics for the Narrows vs. Base Case scenarios (upper table) and Drawdown vs. Base Case scenarios (lower table) at Node 8, Bear River below at Idaho/Utah border.

Constituent	Minimum	25%	Median	Mean	75%	Maximum
Compare Narrows Base Case to Oneida Base Case						
Flow, ft^3/s	-123.1	-5.15	-0.81	-2.51	3.03	184.3
Temperature, °C	-8.775	-0.523	-0.00500	-0.14050	0.2960	5.400
Dissolved oxygen, mg/L	-3.986	-0.006	0.14900	0.21460	0.4020	3.938
Specific conductance, µSiemens	-136.1	15.3	46.6	61.53	88.4	461.4
Chlorophyll a, µg/L	-8.098	-0.208	0.799	2.239	5.103	12.66
Total Phosphorus, µg/L	-0.078	-0.012	-0.00013	-0.00084	0.0067	0.091
Total Nitrogen, mg/L	-0.32	0.239	0.349	0.427	0.51	2.23
Compare Narrows Drawdown Case to Oneida Base Case						
Flow, ft^3/s	-123.1	-5.44	-0.38	1.19	6.39	184.3
Temperature, °C	-8.775	-0.543	-0.006	-0.1495	0.294	9.041
Dissolved oxygen, mg/L	-3.986	-0.006	0.151	0.216	0.405	3.94
Specific conductance, µSiemens	-136.	15.4	46.8	61.4	88.	461.2
Chlorophyll a, µg/L	-8.088	-0.206	0.79	2.259	5.167	12.66
Total Phosphorus, µg/L	-0.078	-0.012	-0.00013	-0.00082	0.0067	0.089
Total Nitrogen, mg/L	-0.32	0.239	0.3489	0.4289	0.518	2.23

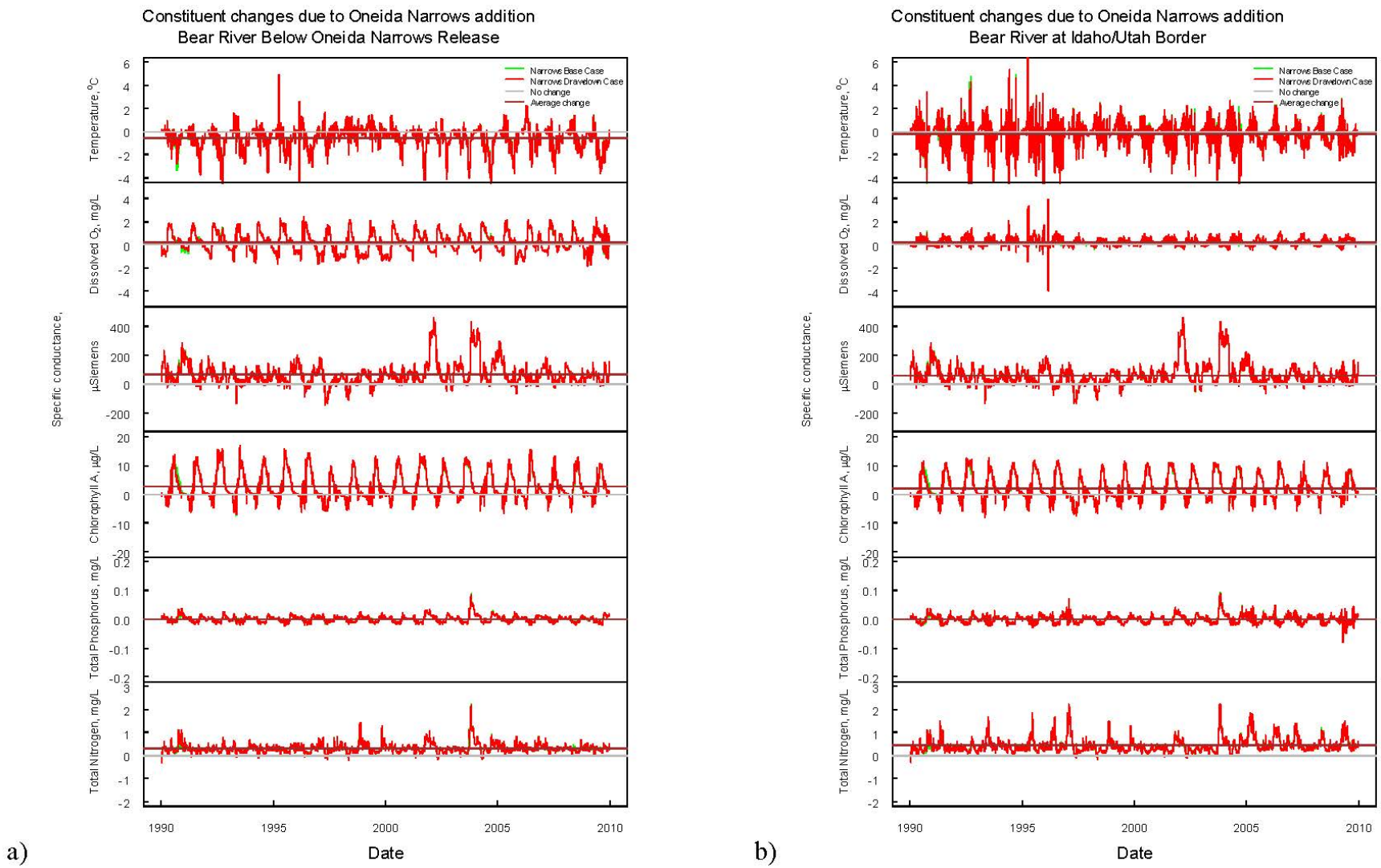


Figure E7-12. Changes in model response due the addition of Oneida Narrows Reservoir (a) below Oneida Narrows Reservoir and (b) at the Idaho/Utah border.

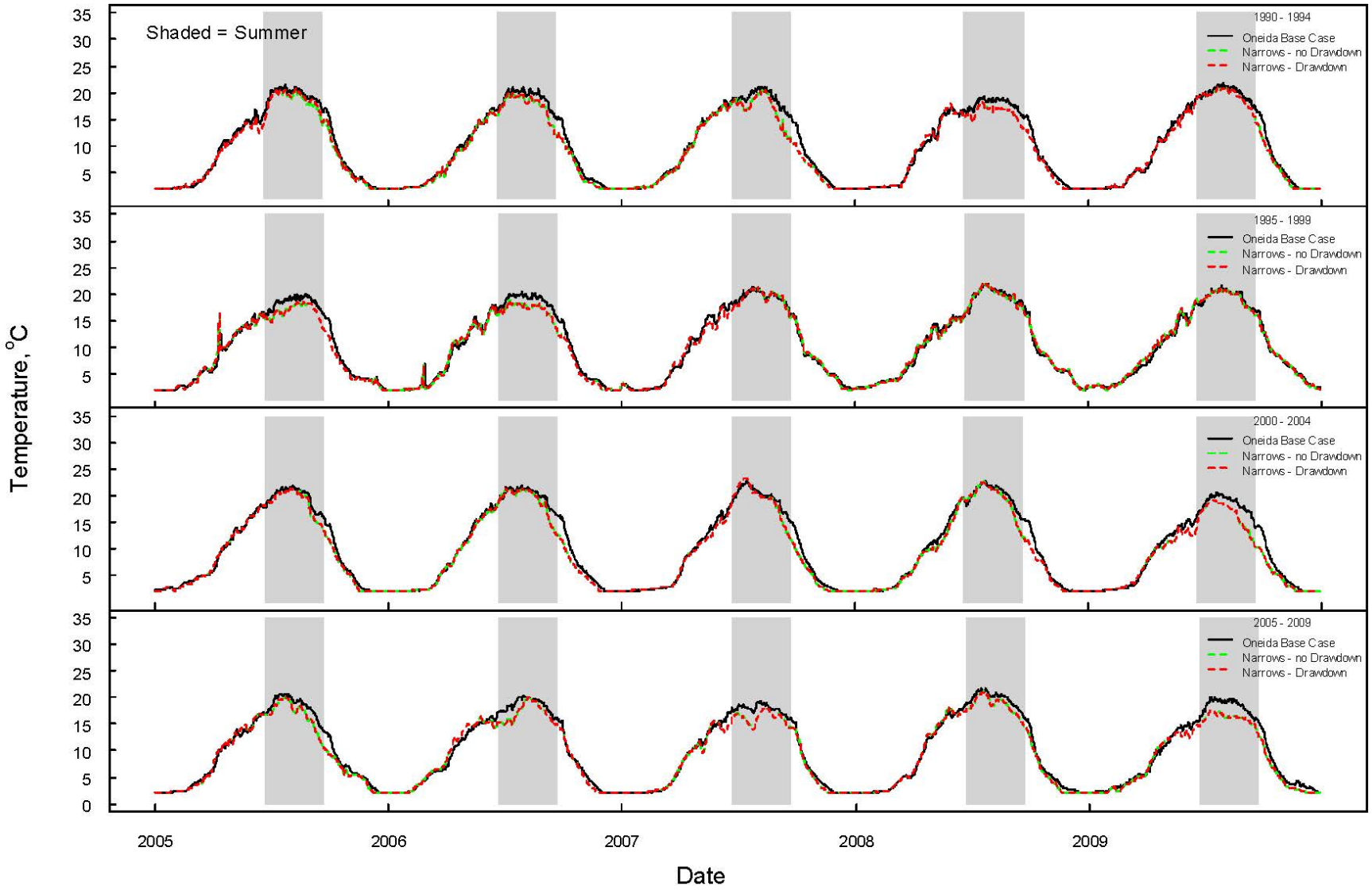


Figure E7-13. Temperature scenario results – Node 17, Bear River below proposed reservoir.

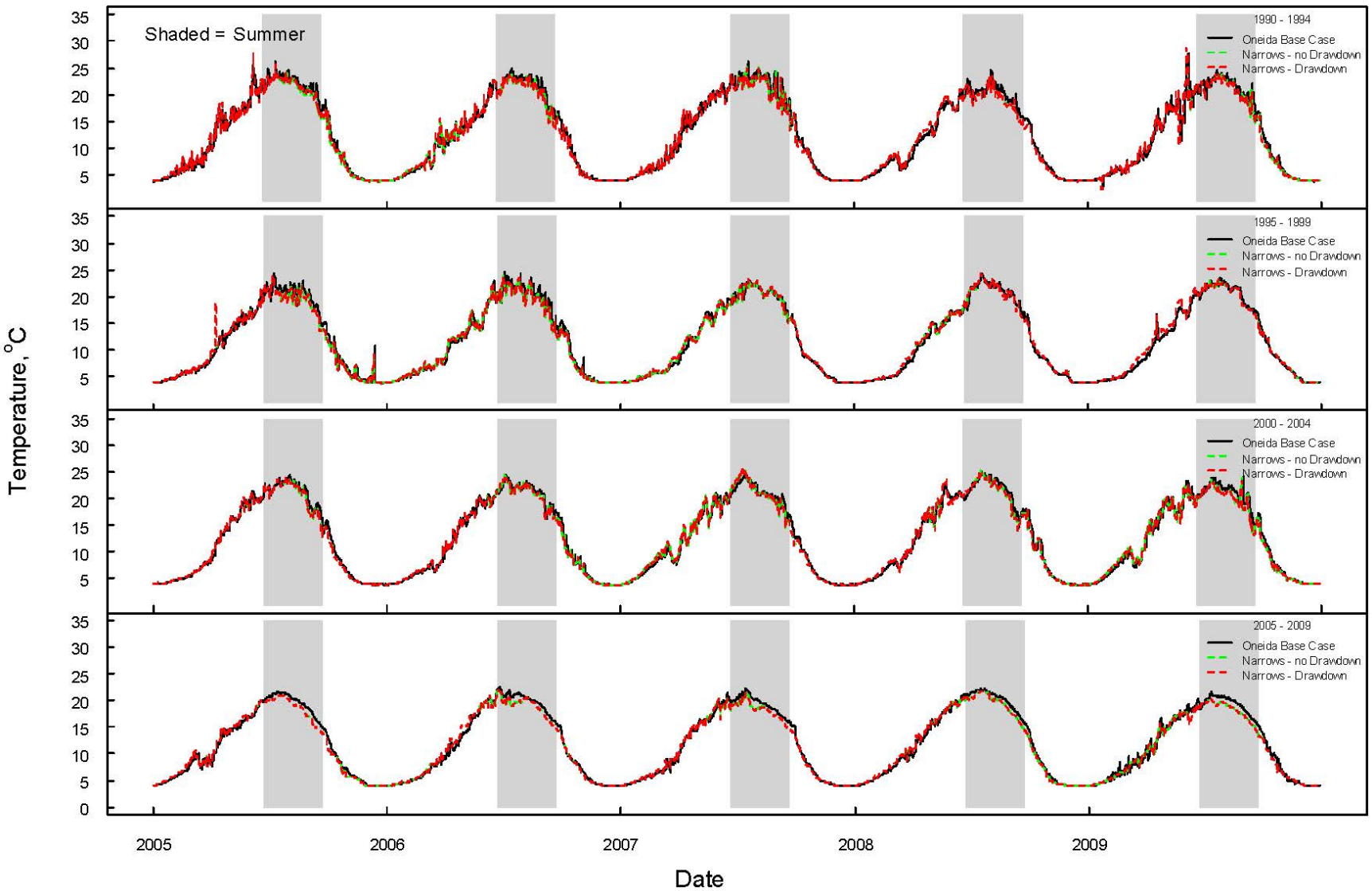


Figure E7-14. Temperature scenario results – Node 8, Bear River at Idaho/Utah border.

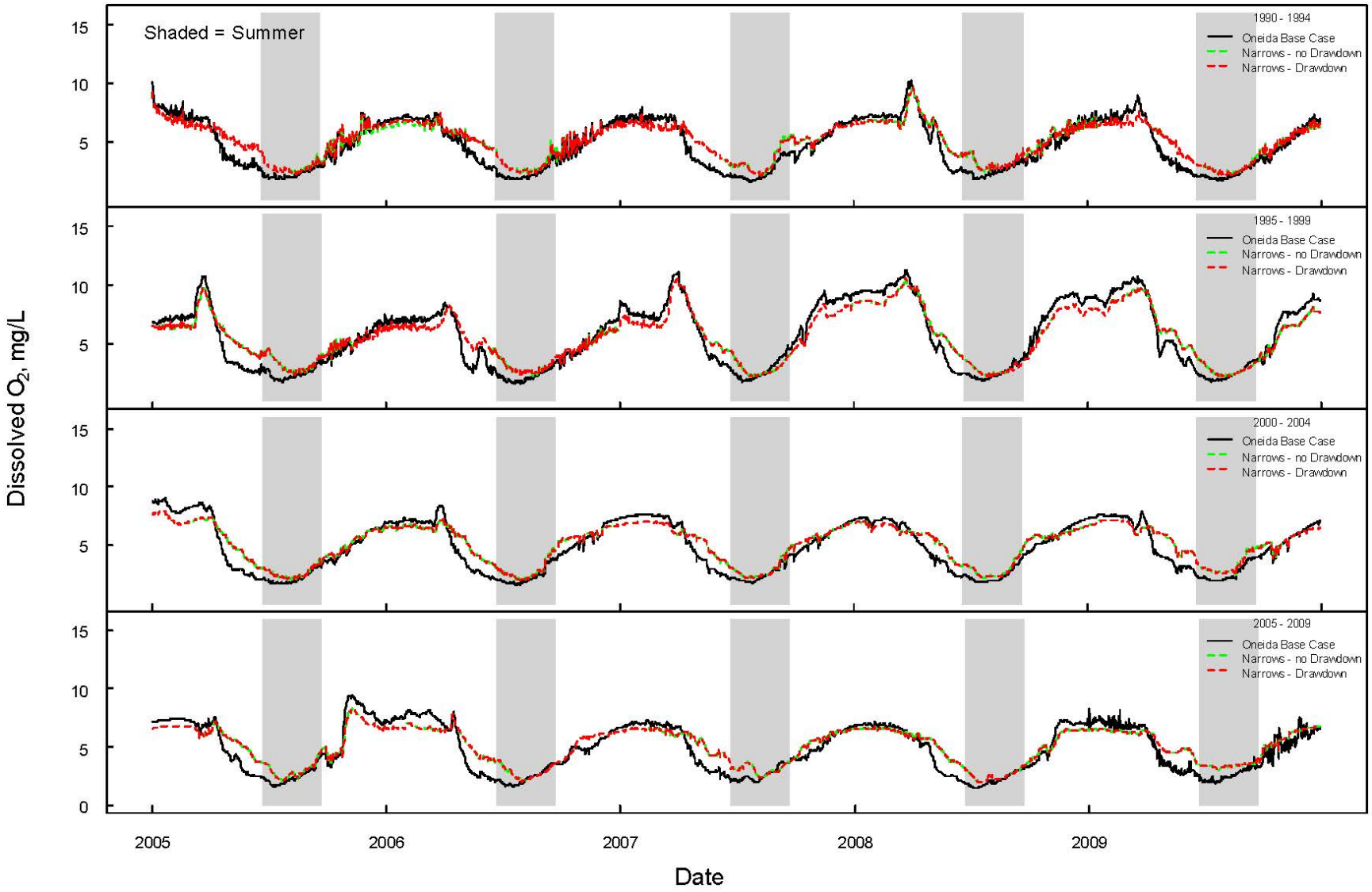


Figure E7-15. Dissolved oxygen scenario results – Node 17, Bear River below proposed reservoir.

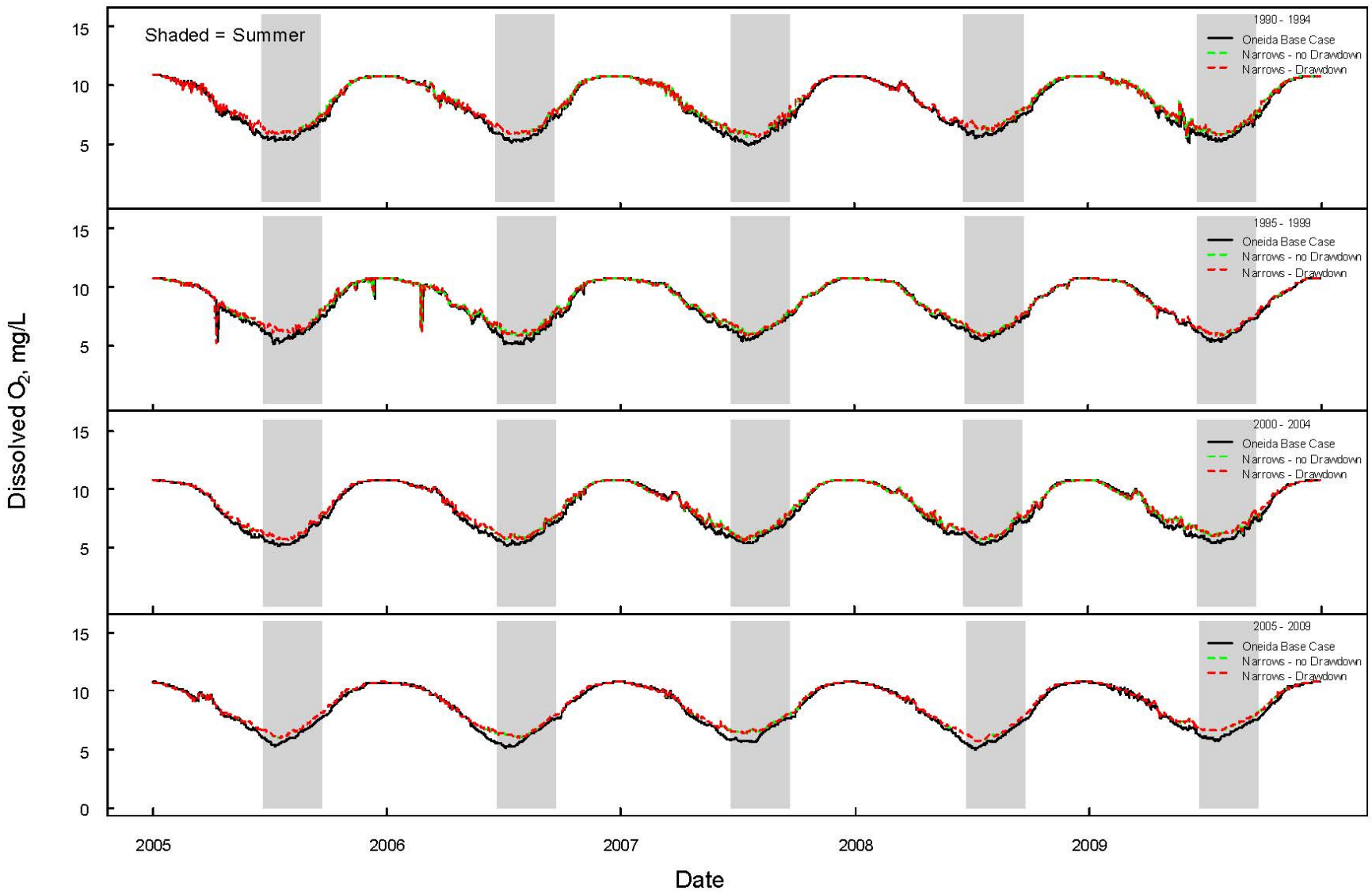


Figure E7-16. Dissolved oxygen scenario results – Node 8, Bear River at Idaho/Utah border.

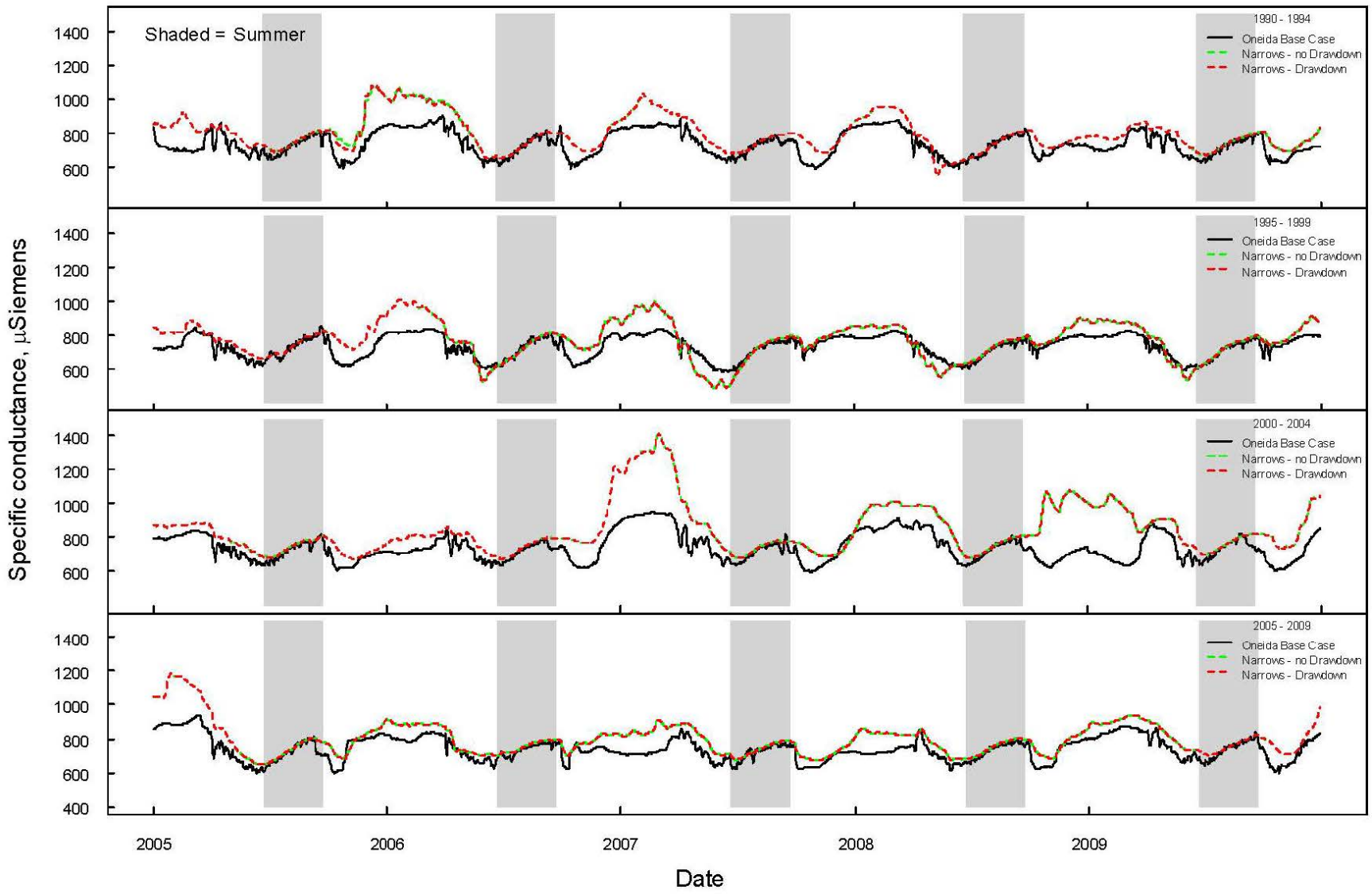


Figure E7-17. Specific conductance scenario results – Node 17, Bear River below proposed reservoir.

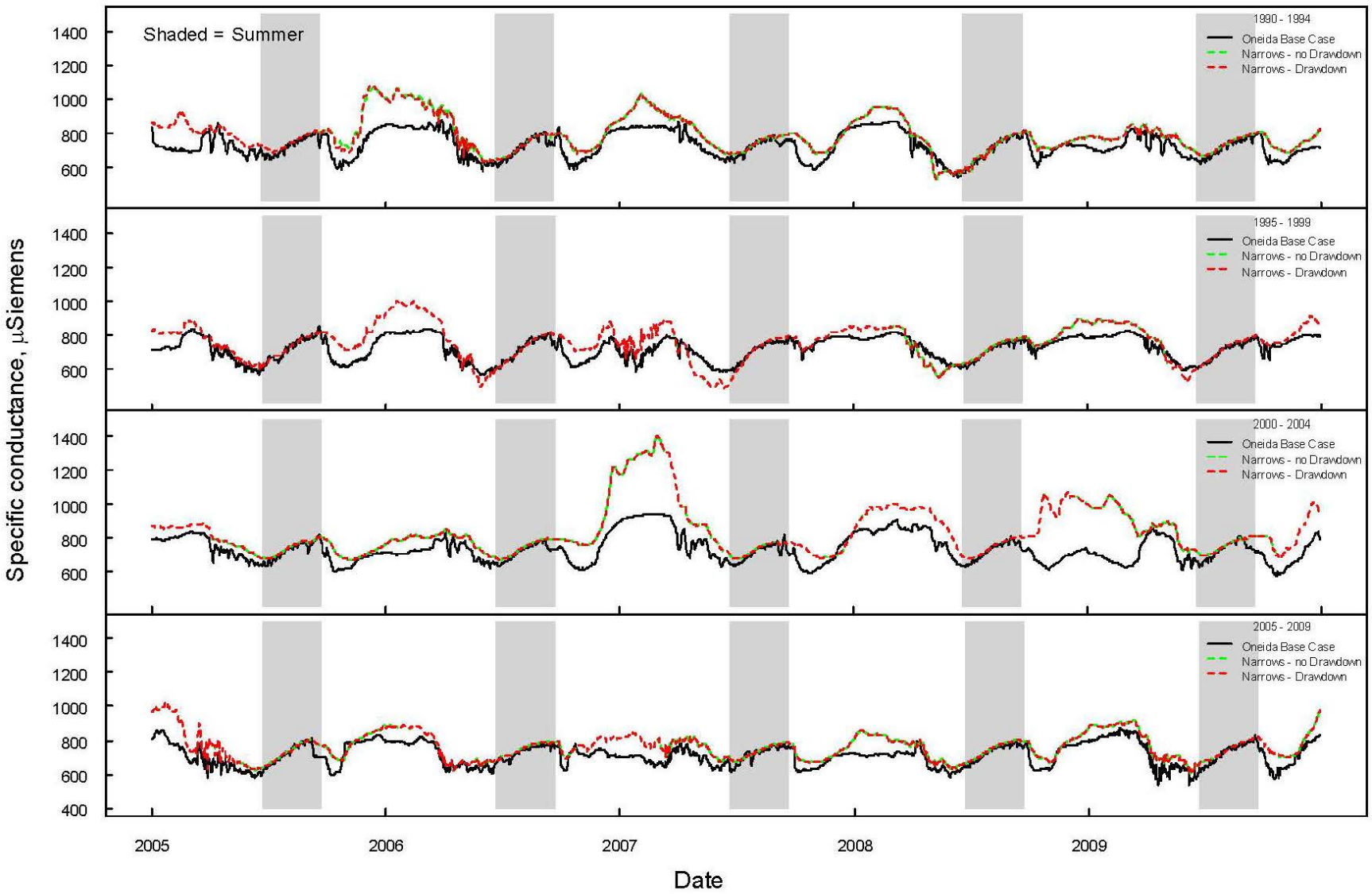


Figure E7-18. Specific conductance scenario results – Node 8, Bear River at Idaho/Utah border.

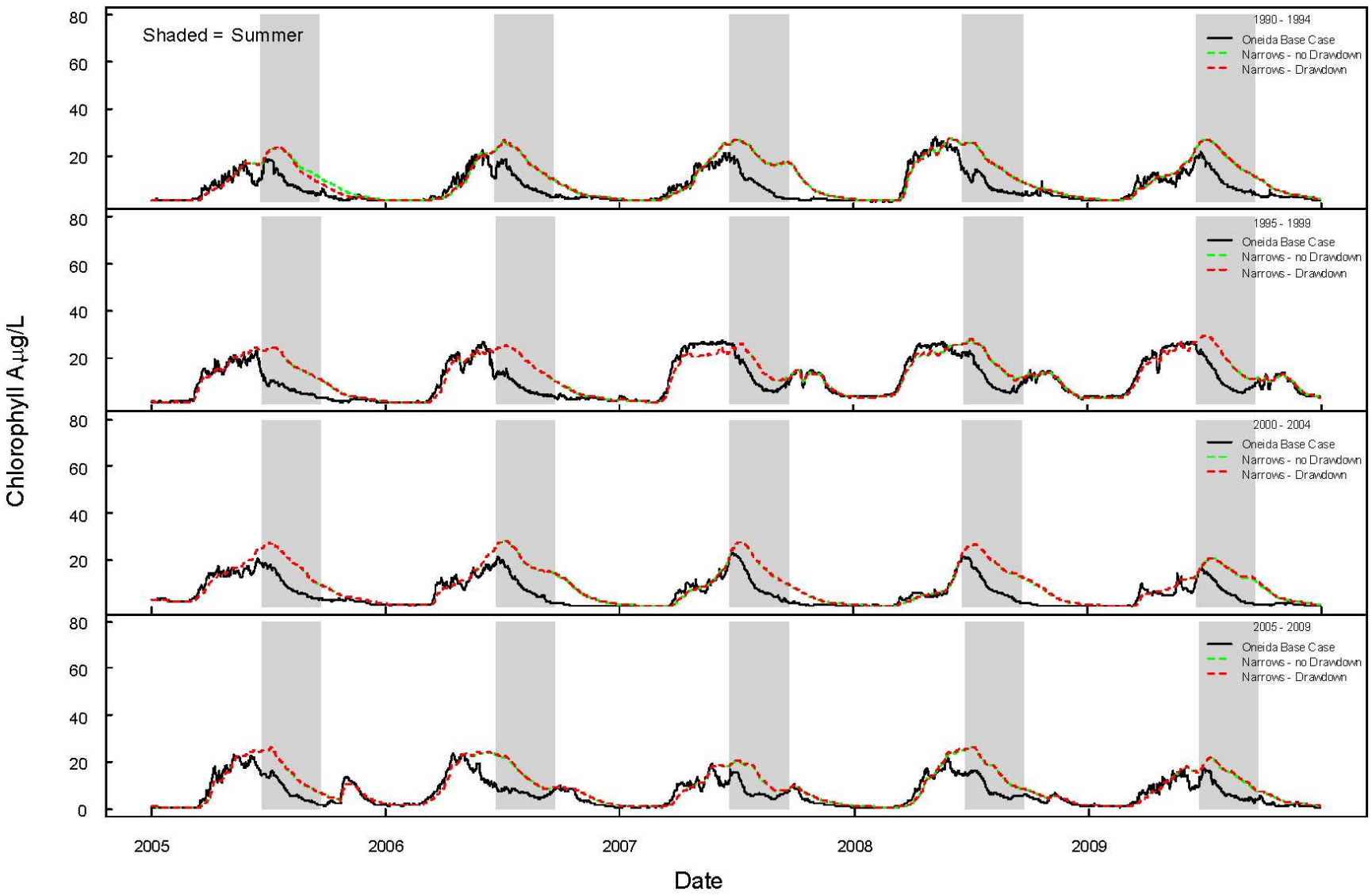


Figure E7-19. Chlorophyll *a* scenario results – Node 17, Bear River below proposed reservoir.

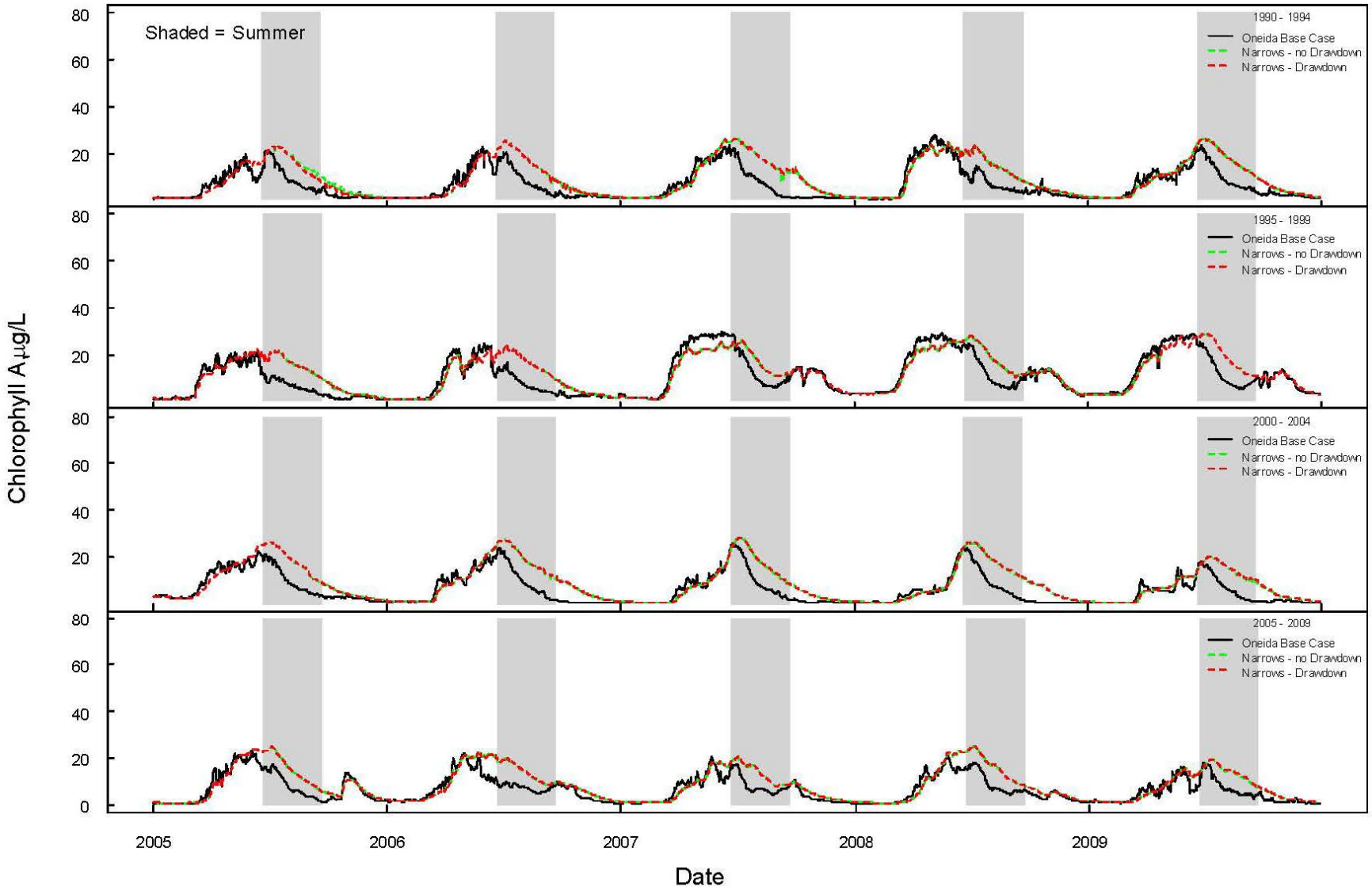


Figure E7-20. Chlorophyll *a* scenario results – Node 8, Bear River at Idaho/Utah border.

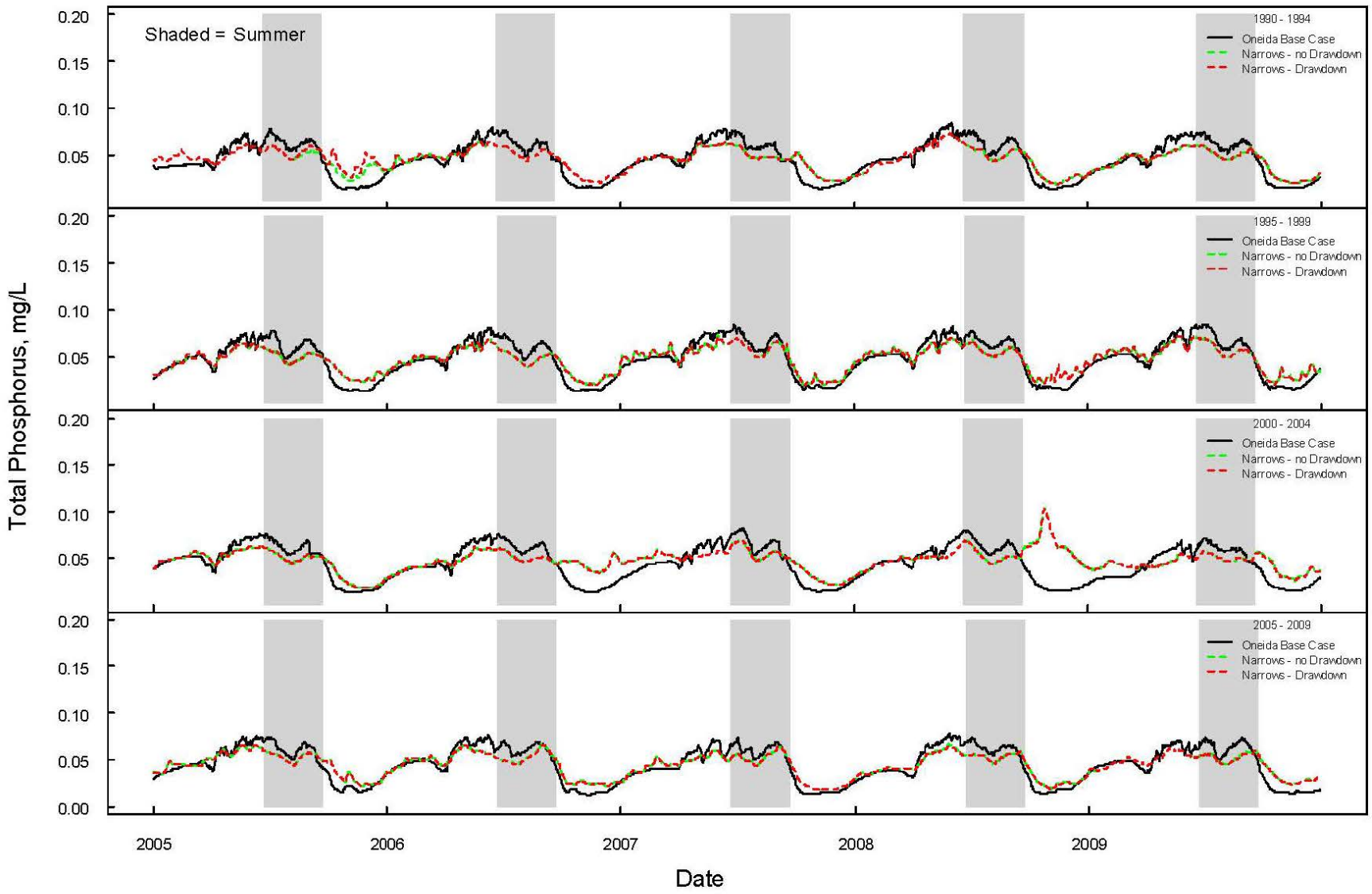


Figure E7-21. Total phosphorus scenario results – Node 17, Bear River below proposed reservoir.

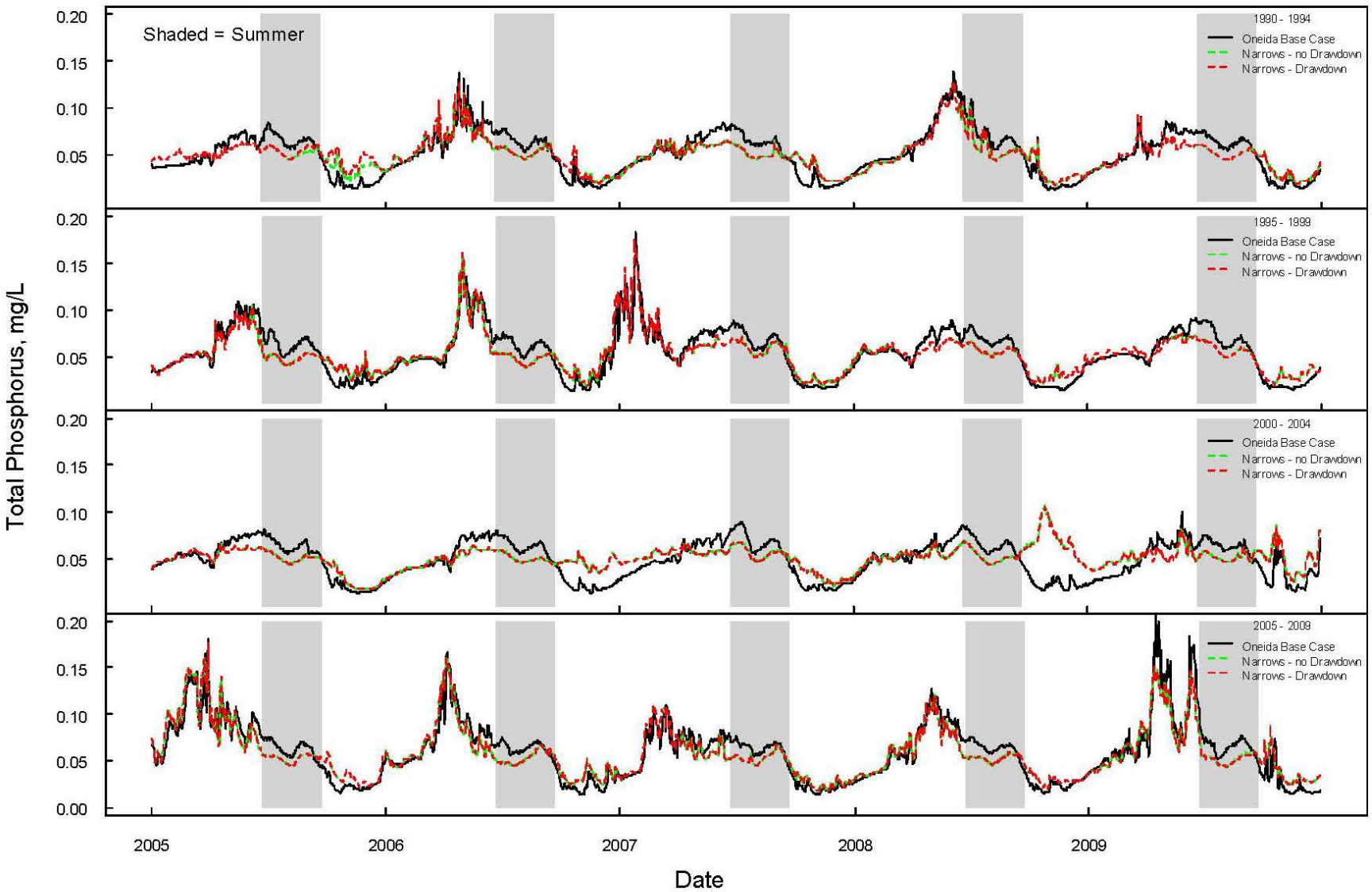


Figure E7-22. Total phosphorus scenario results – Node 8, Bear River at Idaho/Utah border.

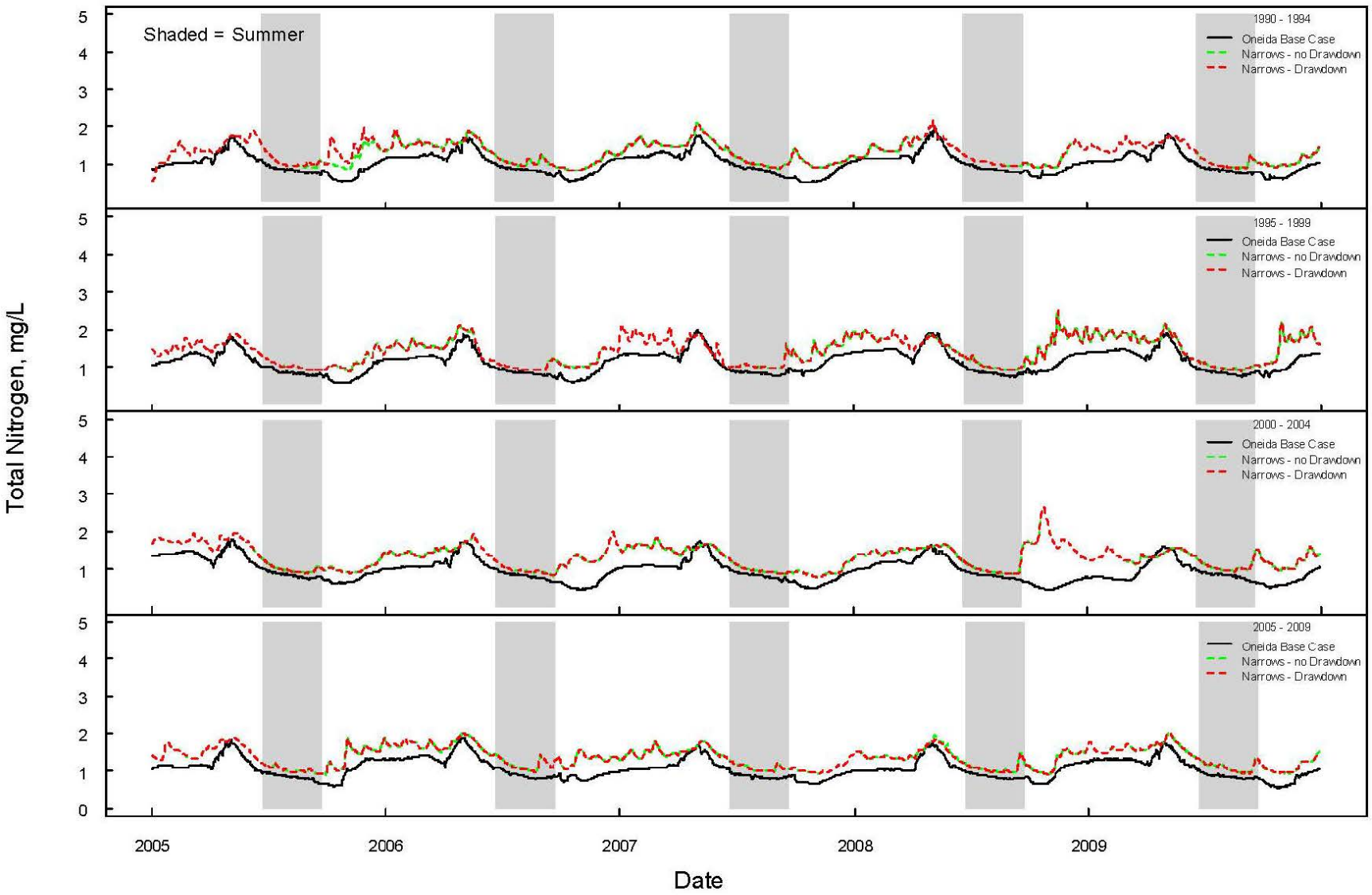


Figure E7-23. Total nitrogen scenario results – Node 17, Bear River below proposed reservoir.

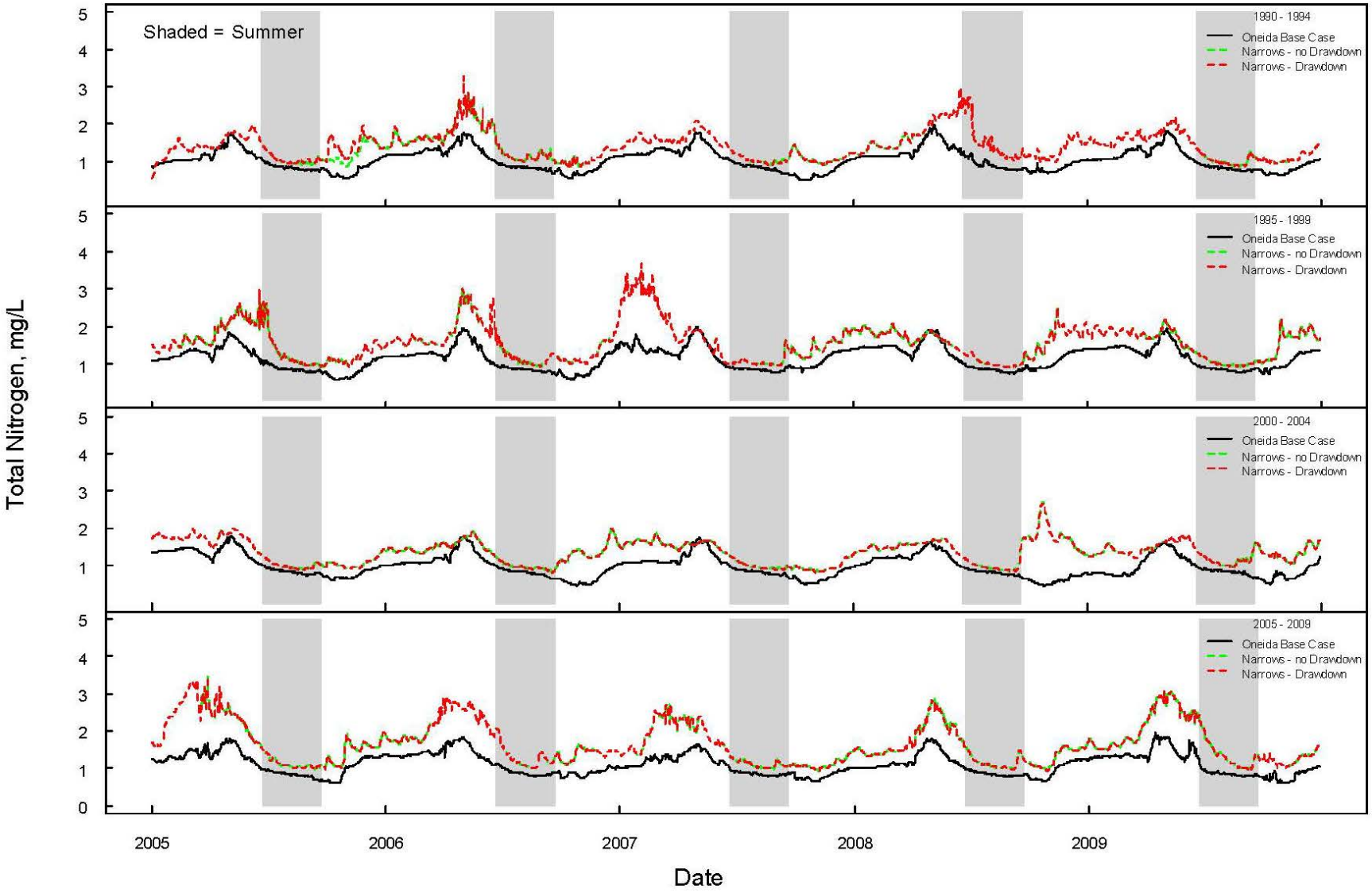


Figure E7-24. Total nitrogen scenario results – Node 8, Bear River at Idaho/Utah border.

7.3.1 DAILY MEAN TEMPERATURE

The statistics in Tables E7-9 and E7-10 show that the overall temperature impact of the new reservoir, whether operated in run-of-reservoir or supplemental irrigation mode, would be small. Detailed temperature plots shown in Figures E7-13 and E7-14 indicate little difference between the run-of-reservoir (Narrows Case) and supplemental irrigation (Drawdown Case). Both operating modes for the new reservoir produce a summer-fall cooling effect during many of the years simulated. The simulations show that this cooling effect persists from the reservoir downstream all the way to the UT/ID border. Table E7-11 shows that the new reservoir, whether operated run-of-reservoir (Narrows Case) or for irrigation benefit (Drawdown Case), would reduce average monthly water temperature in the Bear River below the dam throughout the summer and fall with a maximum difference of 2.1 °C occurring in September. Table E7-12 shows that the temperature reduction persists to the ID/UT border but with a smaller magnitude, probably due to partial equilibration with atmospheric conditions. This cooling benefit from the new reservoir is a result of the deep position of the reservoir outlet gates that release cool hypolimnetic water.

Table E7-11. Average monthly temperature (°C) at node 17 (release point of new reservoir) from 1990 – 2009 for the 3 simulation scenarios.

	N17-Base	N17-Narrows	N17-Drawdown
Jan	2.2	2.2	2.2
Feb	2.7	2.6	2.6
Apr	9.4	9.7	9.7
May	13.8	13.5	13.5
Jun	17.0	16.4	16.4
Jul	20.0	19.0	19.0
Aug	19.8	18.8	18.8
Sep	16.8	14.7	14.7
Oct	9.1	8.1	8.1
Nov	4.2	3.7	3.7
Dec	2.4	2.3	2.3

Table E7-12. Average monthly temperature (°C) at node 8 (ID/UT border) from 1990 – 2009 for the 3 simulation scenarios.

	N8-Base	N8-Narrows	N8-Drawdown
Jan	4.3	4.4	4.4
Feb	5.9	6.1	6.1
Apr	12.4	12.9	12.9
May	16.5	16.7	16.7
Jun	19.8	19.7	19.7
Jul	22.2	21.7	21.7
Aug	21.3	20.6	20.6
Sep	17.5	16.4	16.4
Oct	10.0	9.4	9.4
Nov	5.1	5.0	5.0
Dec	4.0	4.0	4.0

Figure E7-25 shows additional details regarding the reservoir cooling effect for two years, 2004 representing hot and dry conditions and 2009 representing normal conditions. These plots show that the cooling effect begins to develop in late spring, persists to late fall and is slightly greater for the run-of-reservoir operation (Narrows Case) than for the irrigation operation (Drawdown Case). Overall, this tendency to reduce water temperature compared to existing conditions means that the project, whether operated run-of-reservoir or for supplemental irrigation water, would improve compliance with state water quality standards for temperature compared to existing conditions.

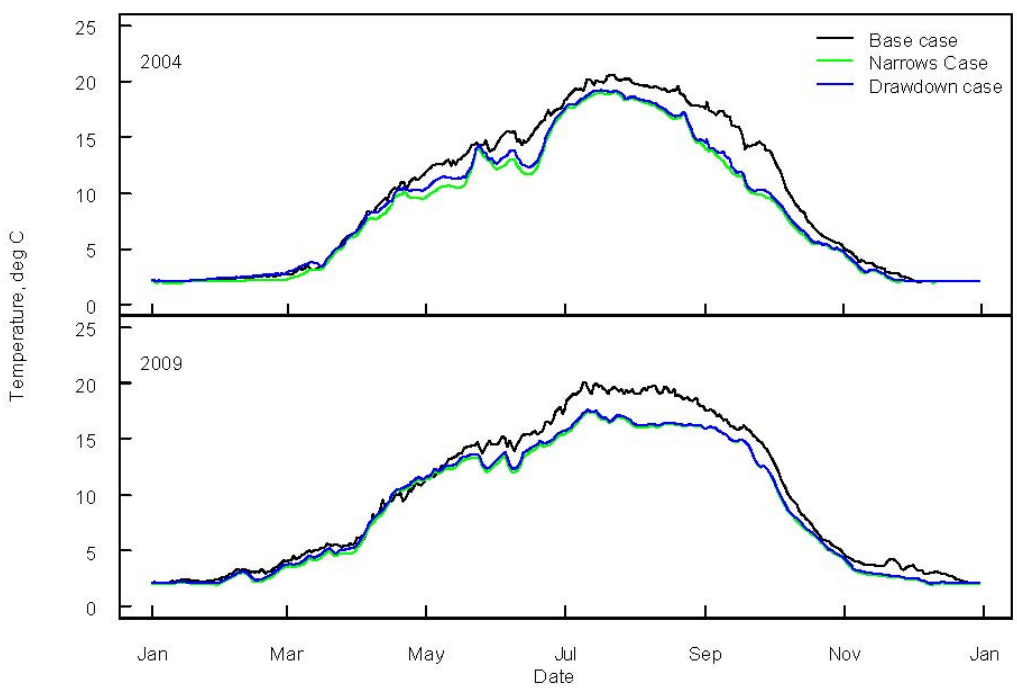


Figure E7-25. Simulated temperature data for 2004 (hot, dry year) and 2009 (normal year).

7.3.2 DIURNAL TEMPERATURE VARIATION

Diurnal temperature variation can be significant and can produce daily temperature extremes that exceed water quality criteria. The character of the diurnal temperature variation in the project area was measured in 2009 at two locations on the Bear River, one just below Oneida Dam and one near the ID/UT border. The extent of the temperature fluctuations observed was ± 1.5 at both locations for the July and August monitoring times (Stevens & Milleson, 2013). Figure E7-26 shows a ± 1.5°C diurnal temperature variation superimposed on simulated dissolved oxygen values (Drawdown Case) for a range of late summer flow conditions. These plots illustrate that in late summer 1) water temperature in the Bear River increases downstream from the project area, 2) average daily water temperature below Oneida Dam occasionally exceeds both the daily average and instantaneous temperature standards under existing conditions, and 3) the diurnal component of water temperature increases non-compliance with the instantaneous temperature standard. However, since diurnal variation would tend to increase the maximum daily water temperature by only 1.5°C above the average daily temperature, it could not cause an exceedance of the instantaneous standard (22 °C) unless the daily average standard (19 °C) was already being exceeded. The proposed project would not be expected to have any significant effect on the magnitude of the diurnal variation since the magnitude depends primarily on climate conditions, which would not change.

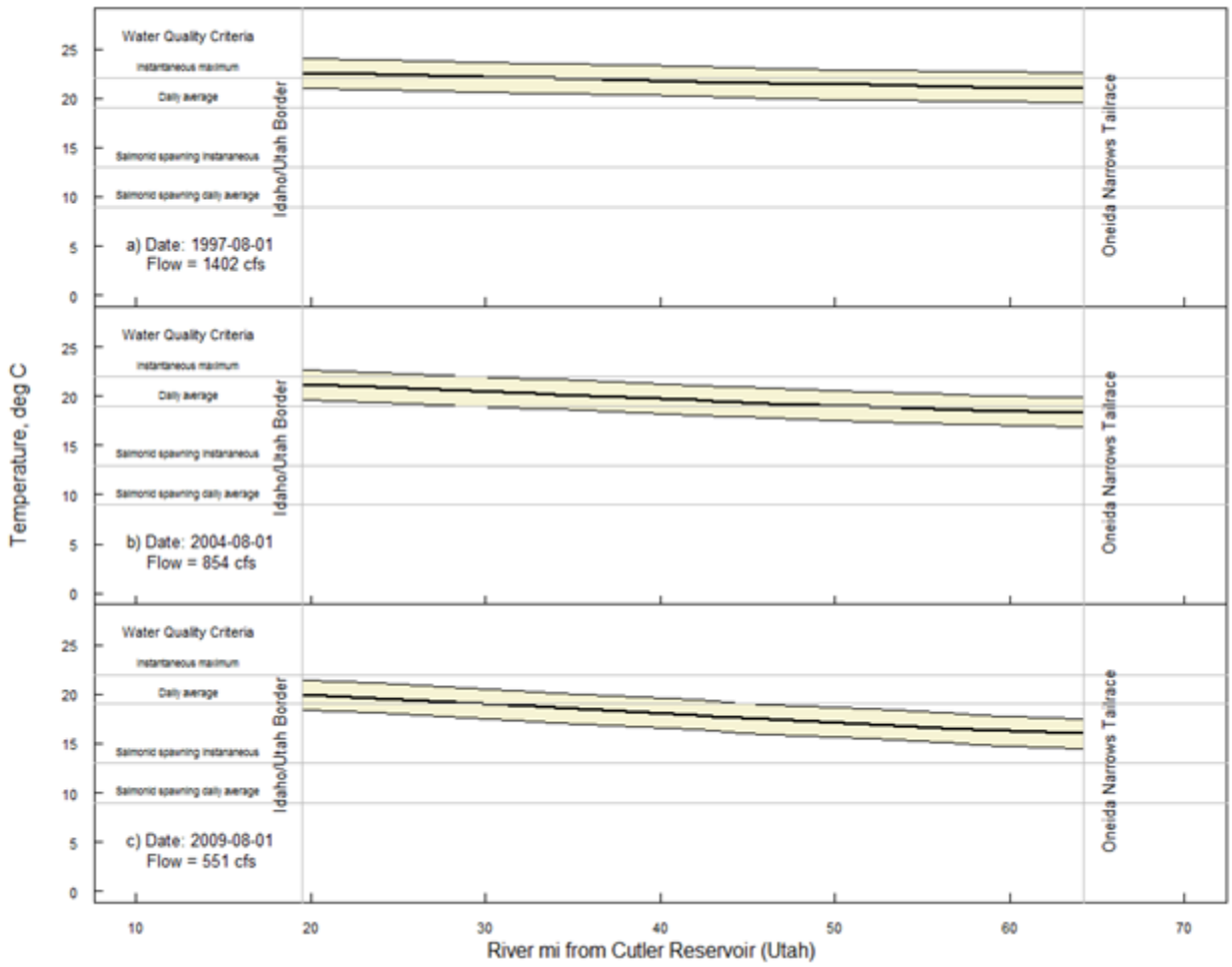


Figure E7-26. Longitudinal temperature profiles for low, medium and high flows. For each flow the heavy central line shows the average daily temperature on Aug 1 at a series of points downstream from the project area. The shaded area shows the extent of diurnal variation observed over a typical late summer 24-hr period.

7.3.3 DAILY MEAN DISSOLVED OXYGEN

The statistics in Tables E7-9 and E7-10 show that the overall dissolved oxygen impact of the new reservoir, whether operated in run-of-reservoir or supplemental irrigation mode, would be minor. Detailed dissolved oxygen plots shown in Figures E7-15 and E7-16 indicate little difference between the run-of-reservoir (Narrows Case) and supplemental irrigation (Drawdown Case). Compared with the base case both operating modes for the new reservoir produce increased dissolved oxygen during spring through summer and produce decreased dissolved oxygen during fall through winter. Tables E7-13 shows that the new reservoir, whether operated run-of-reservoir (Narrows Case) or for irrigation benefit (Drawdown Case), would increase average monthly dissolved oxygen by up to 1.5 mg/L (in May) and would decrease average monthly dissolved oxygen by as much as 0.7 mg/L (in February and March). Table E7-14 shows that the general trends in dissolved oxygen persist to the ID/UT border but are greatly attenuated, probably due to

partial equilibration with atmospheric conditions. The simulations show that during the critical months for low dissolved oxygen, July and August, the presence of the new reservoir has a small but positive effect on dissolved oxygen in the Bear River compared to existing conditions. The values in Table E7-13 show that beginning about May dissolved oxygen levels in water released into the Bear River would fall below the 6.0 mg/L standard for coldwater aquatic life but would continue to meet the relaxed standards that apply below hydroelectric projects (see Table E7-1). However, by July, releases from the new reservoir would no longer meet these standards and would remain out of compliance through about September.

Table E7-13. Model predictions of average monthly dissolved oxygen (mg/L) at node 17 (release point of new reservoir) from 1990 – 2009 for the 3 simulation scenarios.

	N17-Base	N17-Narrows	N17-Drawdown
Jan	7.5	6.9	6.9
Feb	7.5	6.8	6.9
Mar	7.7	7.0	7.0
Apr	5.9	6.6	6.6
May	3.5	5.0	5.0
Jun	2.5	3.8	3.8
Jul	1.9	2.7	2.7
Aug	2.3	2.6	2.6
Sep	3.4	3.7	3.7
Oct	4.6	4.9	4.9
Nov	6.1	6.0	6.0
Dec	7.0	6.6	6.6

Table E7-14. Model predictions of average monthly dissolved oxygen (mg/L) at node 8 (ID/UT border) from 1990 – 2009 for the 3 simulation scenarios.

	N8-Base	N8-Narrows	N8-Drawdown
Jan	10.7	10.7	10.7
Feb	10.3	10.2	10.2
Mar	9.7	9.7	9.7
Apr	8.3	8.4	8.4
May	7.2	7.5	7.5
Jun	6.2	6.7	6.7
Jul	5.5	6.1	6.1
Aug	6.0	6.4	6.4
Sep	7.2	7.5	7.5
Oct	8.9	9.1	9.1
Nov	10.3	10.4	10.4
Dec	10.7	10.7	10.7

Table E7-15 shows model predicted percentage exceedance of dissolved oxygen standards by month at the release from the proposed new dam (node 17). Results are shown for both the run-of-reservoir (Narrows Case) and supplemental irrigation (Drawdown Case) operating modes. The standards for waters below new hydroelectric projects apply in this case (see Table E7-1). The Information in Table E7-15 confirms that the two operating modes have a nearly identical impact on dissolved oxygen and that release of hypolimnetic water from the new reservoir would result in non-compliance with dissolved oxygen standards beginning as early as April and continuing through November.

Table E7-15. Model predictions of dissolved oxygen standards exceedance by month at node 17 (release point of new reservoir) from 1990 – 2009 for the two alternative reservoir operating scenarios.

	% of days <3.5 mg/L instantaneous			% of days <4.7 mg/L 7-day mean			% of days <6.0 mg/L 30-day mean	
	Narrows	Drawdown		Narrows	Drawdown		Narrows	Drawdown
Jan	0%	0%		0%	0%		0%	0%
Feb	0%	0%		0%	0%		0%	0%
Mar	0%	0%		0%	0%		0%	0%
Apr	0%	0%		0%	0%		6%	6%
May	0%	0%		26%	26%		72%	72%
Jun	32%	31%		89%	89%		100%	100%
Jul	94%	95%		100%	100%		100%	100%
Aug	99%	99%		100%	100%		100%	100%
Sep	45%	46%		88%	92%		100%	100%
Oct	0%	1%		45%	45%		100%	100%
Nov	0%	0%		1%	1%		85%	85%
Dec	0%	0%		0%	0%		29%	27%

Table E7-16 shows model predicted percentage exceedance of dissolved oxygen standards by month at the ID/UT border (node 8). Results are shown for both the run-of-reservoir (Narrows Case) and supplemental irrigation (Drawdown Case) operating modes. The standards for coldwater aquatic life have been applied in this case (see Table E7-1). The Table E7-16 figures show that by the time the Bear River reaches Utah the dissolved oxygen has largely recovered due to re-aeration and atmospheric equilibration but occasional exceedances can still occur in late summer.

Table E7-16. Model predictions of dissolved oxygen standards exceedance by month at node 8 (ID/UT border) from 1990 – 2009 for the two alternative reservoir operating scenarios.

	% of days <6.0 mg/L instantaneous	
	Narrows	Drawdown
Jan	0%	0%
Feb	0%	0%
Mar	0%	0%
Apr	0%	0%
May	0%	0%
Jun	1%	1%
Jul	34%	33%
Aug	12%	12%
Sep	0%	0%
Oct	0%	0%
Nov	0%	0%
Dec	0%	0%

7.3.4 DIURNAL DISSOLVED OXYGEN VARIATION

The impact of the Narrows Dam on dissolved oxygen also involves assessment of oxygen variation over the diurnal cycle. The project is expected to have little or no effect on the magnitude of the dissolved oxygen diurnal cycle since, as discussed below, the project's impact on algae growth is expected to be small. Therefore the existing dissolved oxygen diurnal variation provides a reasonable estimate of the post-project variation. Figure E7-27 shows a ± 3 mg/L dissolved oxygen diurnal variation, the most extreme variation observed during 2009 surveys (Stevens & Milleson, 2013), superimposed on simulated dissolved oxygen values (Drawdown Case). These plots illustrate that in the critical late summer time frame 1) re-aeration effects raise average dissolved oxygen levels significantly (4 – 5 mg/L) over the first 10 -12 miles below the new reservoir, 2) even with re-aeration average dissolved oxygen can fail in some cases to comply with the 6.0 mg/L cold water dissolved oxygen standard as far as 35 miles downstream of the project, and 3) the diurnal variation creates daily periods of low DO that would likely result in violation of the 6.0 mg/L cold water standard throughout the modeled reach of the Bear River.

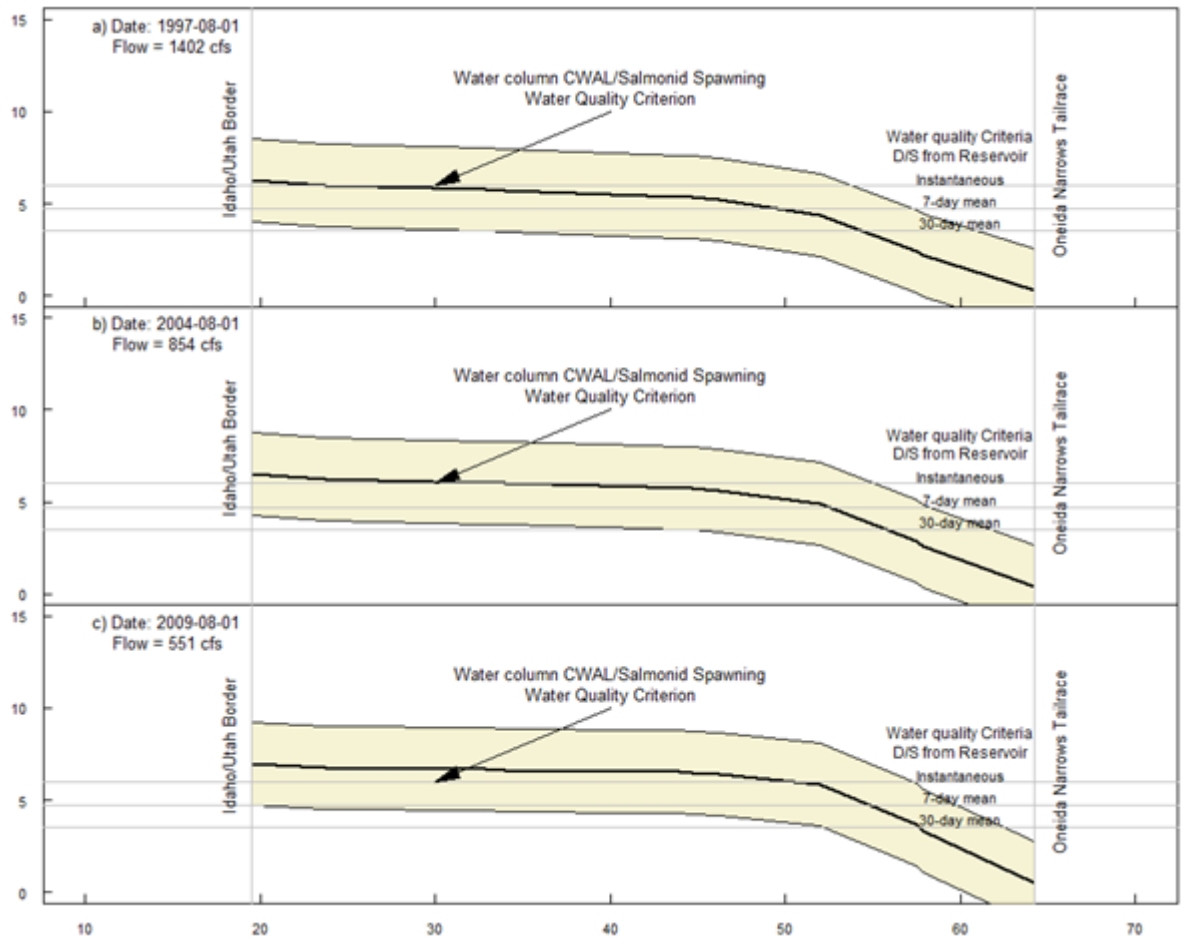


Figure E7-27. Longitudinal dissolved oxygen profiles for low, medium and high flows. For each flow the heavy central line shows the average daily DO (mg/L) on Aug 1 at a series of points downstream from the project area. The shaded area shows the extent of diurnal variation observed over a typical late summer 24-hr period.

7.3.5 DAILY MEAN CHLOROPHYLL A AND NUTRIENTS

Chlorophyll *a*, total phosphorus and total nitrogen scenario results are shown in Figures E7-19 through E7-24. The modeling predicts overall increases for chlorophyll *a* during the algae growing season due to the availability of extra volume and residence time within the new reservoir, which will be released downstream. The median change in chlorophyll *a* is 1 and 0.8 µg/L, at Nodes 17 and 8, and ranges from about -7 to 17 µg/L at node 17 and -8 to 13 µg/L at node 8.

Total phosphorus (TP) is predicted to decrease by median values of 0.01 and 0.13 µg/L at the two nodes (range of -24 to 87 µg/L for node 17 and -78 to 91 µg/L at node 8). Total nitrogen (TN) is predicted to increase by median values of 260 and 350 µg/L at the two nodes (range of -320 to

2200 μg/L at both nodes)[3]. Some of these nitrogen increases are due to the increase in chlorophyll *a* that carries nutrients with it, but this in large part reflects the increased influx of nutrients via benthic sources being captured and discharged to the receiving water.

Before discussing the implications of the simulated changes in nutrients and chlorophyll *a* from the proposed Narrows Dam, the reasons for the changes require clarification. The model for the proposed Narrows Dam was run using identical parameters as for the existing Oneida Reservoir model, with the only differences being the reservoir geometry and the influent flow and water quality conditions. The Narrows Dam geometry was derived from the digital elevation model data for the Narrows Dam site, converted to a bathymetry grid, and then into reservoir basins and layers for simulation, subject to the modifications for drawdown described above. The input flow and water quality to the Narrows Dam model over the simulation period were the output flow and water quality simulated from the Oneida Reservoir model as modified by the inter-reservoir river reach.

Included in the parameter list for the Narrows Dam were the benthic fluxes of nitrogen, estimated from the Oneida Reservoir model as around100 μg-N/m^2/min used in calibration to close the nitrogen balance (no phosphorus flux was required to close the mass balance). This same flux was used in the Narrows Dam model and would increase the total amount of nitrogen released from the Narrows Dam over that released from Oneida Reservoir. This assumption is conservative because the accumulation of nitrogen-containing sediment in Oneida Reservoir over the life of the dam is the source of the nitrogen release to the water column. No such accumulation has occurred for the Narrows Dam and is unlikely to occur because the sediment is removed nearly completely in Oneida Reservoir. The benthic material in the Narrows Dam will be the river channel and the hill sides flooded by the increased water level and are mainly free of these historically accumulating sediments that exist in Oneida Reservoir.

Generally higher nutrient concentrations drive increased algae growth and thus larger diurnal variations in stream dissolved oxygen. However, in the Bear River, existing conditions are such that little additional increase in chlorophyll *a* should be observed. The nutrient concentrations under the Base Case scenario produce a maximal algae growth rate given the travel time and light availability (Gotham and Rhee, 1981b, Messer, Grenney and Ho, 1983) so little additional growth is expected due to the increased nutrient concentrations. In addition, the QUAL2E model accounts for the impact of the increase in chlorophyll *a* in the release from Narrows Dam and, as was shown above, the impact on the averaged dissolved oxygen concentration was small.

The nutrient increase has a seasonal character in which the impact of the Narrows Dam is felt more during fall through spring than in summer. In the colder months, the bulk of the nutrient release from the reservoir is in dissolved form and, though more available to algae, colder temperatures

[3] The result for total phosphorus and total nitrogen are different than in the draft report. Focusing on total phosphorus, preliminary calculations showed a small increase in the Narrows Dam scenario vs. the Base Case of 3 μg/L averaged over the 20 year simulation period, a level that was considered to be little different than analytical error. During the TMDL Assessment calculations, an error in the mass balance was discovered and corrections to those calculations reversed the increase to the decrease of 8-10 μg/L, which is also considered small and little different than the noise.

and shading from ice cover reduce the ability of algae to take up the nutrients. Thus, the bulk of the increased nutrient load passes through the Bear River below the reservoir with little uptake. In summer more of the nutrients are in particulate form, primarily algae washed from the reservoir, and are less available to benthic algae.

7.3.6 SEASONAL CHARACTER OF WATER QUALITY IMPACTS

Figure E7-28 shows box/whisker summary plots of the differences (from the Base Case) between the run-of-reservoir (narrows Case) and supplemental irrigation (Drawdown Case) operating scenarios. The plots are broken out by location, Node 17 at the reservoir release point and Node 8 at the ID/UT border, and by season. It is apparent from these plots that there is little difference between the water quality effects associated with the alternative operating modes for the new reservoir. It is also apparent that predicted impacts to temperature, dissolved oxygen and nutrient have a distinct seasonal character.

At Node 17, at the release point from the new reservoir, the model predicts little change to temperature during winter and fall. However during spring and summer the results show significant decreases in temperature compared to the Base Case. Dissolved oxygen is predicted to increase during spring and summer and decrease during fall and winter compared to the Base Case. Total phosphorus concentrations are predicted to decrease in spring and summer with little change expected in fall and winter. Nitrogen is predicted to increase on a year round basis, with larger decreases occurring in fall and winter. At Node 8, near the Idaho/Utah border, the model predicts the scenario difference results are similar to those at Node 17, with the exception that the spring temperature results show a slight increase in both scenarios and the spring and summer increases in dissolved oxygen are less pronounced. These seasonal effects suggest that the addition of the Narrows Dam under either the run-of-reservoir or supplemental irrigation operating mode will tend to improve temperature and dissolved oxygen conditions, particularly during the critical late summer period. Nutrient concentration would also have a seasonal component.

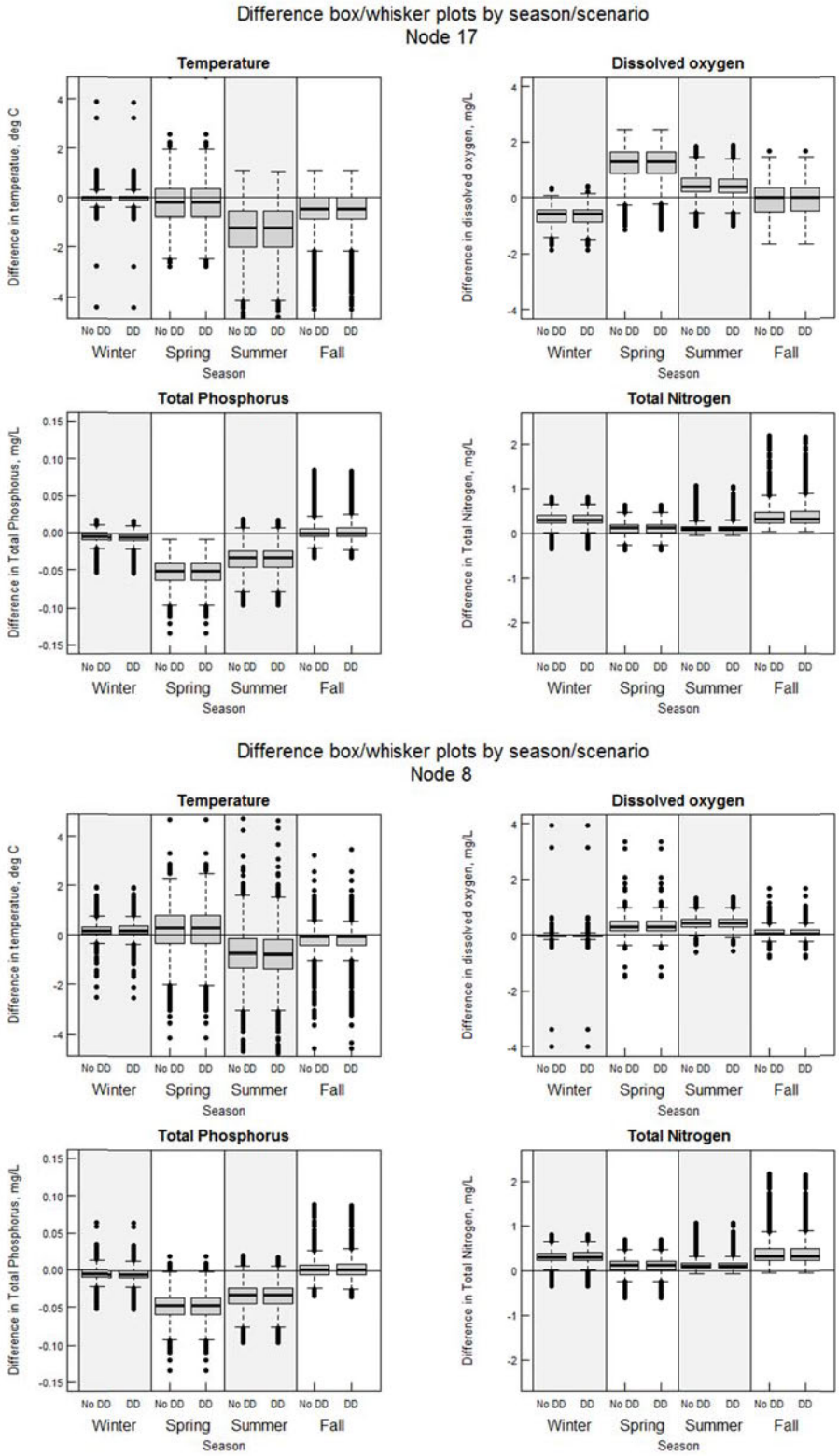


Figure E7-28. Box/whisker plots comparing water quality implications of run-of-reservoir (Narrows Case) and supplemental irrigation (Drawdown Case) operating modes at Node 17 and

Node 8. Each set of shaded pairs shows the Narrows Case on the left and the Drawdown Case on the right. Values plotted are the differences relative to the Base Case.

7.3.7 SEDIMENT

Twin Lakes conducted an analysis of the potential for increased sedimentation due to fluctuating water levels in the proposed reservoir that would occur under the supplemental irrigation operating mode. A draft report on this effort was prepared (Stevens, 2013) but has not yet been finalized. The main conclusions are:

- With highly conservative assumptions it is estimated that over 20 years a total of approximately 2.2 inches of soil would be eroded from the 100 acre area exposed during maximum reservoir drawdown;
- With relaxed "best estimate" assumptions it is estimated that over 20 years a total of approximately 0.9 inches of soil would be eroded from the 100 acre area exposed during maximum reservoir drawdown;
- It is estimated that a 100 yr flood flow during full reservoir drawdown could mobilize sediment and increase sediment concentration in the Bear River by an increment of 249 mg/L (best estimate) to 749 mg/L (worst case).

This potential incremental increase in sediment load is modest when taken in the context of existing sediment concentrations in the Bear River which, from 1987 - 1996, exhibited daily averages between 60 mg/L to 2,000 mg/L at the ID/UT border.

7.3.8 ASSESSMENT WITHIN TMDL CONTEXT

The Total Maximum Daily Load (TMDL) Subbasin Assessment for the Idaho Bear River Basin, Idaho studied the load reductions required to bring the Bear River into compliance with the IDEQ water quality criteria and standards (IDEQ 2011a). Pursuant to that assessment, Ecosystems Research Institute (2006) found that the portion of the Bear River Basin impacted by Twin Lakes' proposed hydroelectric project, Bear River from Oneida Reservoir to the ID/UT Border, is out of compliance with standards and criteria for suspended sediment (TSS) and total phosphorus (TP). The purpose of this section is to analyze the impact that the addition of the Narrows Dam will have on the ability of IDEQ to bring this portion of the Bear River into compliance.

The goal of the TMDL is to establish those loads of pollutants that will bring a system into compliance. This is established on the basis of the sum of the natural background loads, waste load allocations (permitted point discharges), load allocations (non-point loads) and a suitable margin of safety. Because the EPA defines point loads as permitted discharges, the impact of the proposed Narrows Dam must be assessed on the basis of the sum of the natural background and non-point loads. In essence, because background data are not available to determine this separately the assessment of the Narrows Dam's impact focuses on whether the Narrows Dam would either mitigate or exacerbate non-point loads.

Ecosystems Research Institute (2006) found that the reach of the Bear River from below Oneida Reservoir to the ID/UT state line contained tributaries that accounted for 75 percent of the TP load within this management reach during upper basin runoff (May to July, see Section 6.1.1). In the

remaining periods, tributaries were 6 to 30 percent of the total TP load entering the river. The highest non-point loads occurred during lower basin runoff (March to April, 272 kg TP/day) and the lowest loads occurred during upper basin runoff (62 kg TP/day). An inspection of the loadings of TP and TSS entering the state of Utah show that TSS does not exceed the TMDL criteria load for any hydrologic time period while TP exceeds criteria (0.050 mg P/L) at all times.

Tables E7-17 and E7-18 show the historical and TMDL assessment loads for total suspended solids and total phosphorus for the Bear River at the Oneida Release and at the ID/UT state line. Table E7-17 shows that the historical and current loads for total suspended solids are well below the TMDL allowances for all time periods and both locations. Table E7-18 shows, however, that the loads for total phosphorus exceed the TMDL allowance in nearly all cases, with the exception of Winter Base Flow below Oneida Reservoir. Table 45 sets forth the goals of the TMDL implementation plan for finding reductions of total phosphorus so that the loads meet the allowance consistently.

Table E7-17. Summary of TMDL Load Assessment – Total Suspended Solids

Time Period	Location			
	Below Oneida Reservoir		At ID/UT State Line	
	Total Suspended Solids (kg/d)	TMDL Allowance (kg/d)	Total Suspended Solids (kg/d)	TMDL Allowance (kg/d)
Winter Base Flow	6,997	65,725	76,365	124,927
Lower Basin Runoff	18,464	145,711	134,181	187,565
Upper Basin Runoff	19,028	148,175	104,582	220,813
Summer Base Flow	6,997	92,167	82,353	134,970

Table E7-18. Summary of TMDL Load Assessment – Total Phosphorous.

Time Period	Location			
	Below Oneida Reservoir		At ID/UT State Line	
	Total Phosphorus (kg/d)	TMDL Allowance (kg/d)	Total Phosphorus (kg/d)	TMDL Allowance (kg/d)
Winter Base Flow	42	55	188	104
Lower Basin Runoff	109	91	467	117
Upper Basin Runoff	107	93	337	138
Summer Base Flow	81	77	200	112

For the Base Case, Narrows Case and Drawdown Case model scenarios loading estimates were calculated for Total Phosphorus at the Oneida Reservoir/Narrows Dam release and in the Bear River at the ID/UT Border overall and during the flow periods defined in the TMDL assessment. Results are shown in Table E7-19. At the two locations the net decrease in total phosphorus from the Base Case averages 4.4% and 5.5%, respectively with some seasonal variation – with increases during the winter base flow and lower basin runoff periods and decreases during summer base flow and the upper basin runoff period. Although the net changes over the 20 year scenario are modest, the total phosphorus reductions during summer and fall should help reduce fluctuations in dissolved oxygen. The lower summer and fall temperatures tend to reinforce this effect.

Table E7-19. Total phosphorous loading estimates for the Base Case, Narrows Case and Drawdown Case.

Time Period	Location									
	Narrows/Oneida Release					ID/UT Border				
	Oneida Base Case	Narrows Base Case	Narrows Drawdown Case	% change Base	% change Draw down	Oneida Base Case	Narrows Base Case	Narrows Drawdown Case	% change Base	% change Draw down
Overall	102.1	97.6	97.6	-4.4	-4.4	125.9	118.9	118.9	-5.5	-5.5
Winter Base Flow	42	49.8	49.9	18.3	18.6	53	61.1	61.2	15.4	15.4
Lower Basin Runoff	111.5	112.2	112.2	0.70	0.70	164	164.4	164.4	0.17	0.20
Upper Basin Runoff	185.8	160.2	159.7	-13.9	-14	226.6	192.8	192.6	-14.9	-15
Summer Base Flow	90.4	88.0	88.0	-2.7	-2.7	95	90.41	90.39	-4.8	-4.8

7.3.9 SUMMARY OF PROJECT EFFECTS ON WATER QUALITY

Based on modeling, the most significant water quality impacts of the proposed Oneida Narrows Reservoir would be:

- During the critical summer-fall period of historically high water temperature, the presence of the new reservoir would reduce water temperatures in the downstream Bear River compared to existing conditions and the reduced temperature would persist to the ID/UT border;
- During the critical summer-fall period of historically low dissolved oxygen, water releases from the new reservoir would increase dissolved oxygen levels compared to releases from Oneida Dam, but would still not meet some state water quality criteria in the river below the dam or at the ID/UT border;
- Modeling predicts that the new reservoir would reduce total phosphorous loading in the Bear River by about 5% compared to existing conditions;

- Modeling predicts that the new reservoir would increase total nitrogen throughout the year, with the largest increases occurring in fall and winter;
- The existing nutrient concentrations in the Bear River produce a maximal algae growth rate given the travel time and light availability, so little additional algae growth is expected due to the predicted nitrogen increases;
- With an overall cooling effect on water temperature and no predicted change in algae concentrations, the project is not expected to increase (and could potentially decrease) the amplitude of diurnal dissolved oxygen swings;
- Drawdown would expose up to 100 acres of reservoir area to erosion but the amount of mobilized sediment, even in the case of a 100 yr flood flow during full drawdown conditions, is predicted to be modest (249 - 749 mg/L) in comparison to existing sediment loads (up to 2,000 mg/L average daily concentration at ID/UT border).

7.4 Proposed Mitigation Measures To Minimize Effects on Water Quality

Twin Lakes proposes the following measures as mitigation for adverse project effects on water use and water quality:

- Twin Lakes would provide a mandatory, year-round minimum flow of 10 cfs in Mink Creek below the Twin Lakes diversion;
- Twin Lakes would implement a Dissolved Oxygen Management Plan whereby measures would be taken to assure that water released from the project into Bear River would comply with applicable water quality standards;
- At the option of project stakeholders Twin Lakes would, consistent with irrigation demands and other water delivery requirements, operate the new reservoir in a manner that absorbs flow pulses from Oneida Dam and provides more uniform flow in the downstream Bear River.

7.4.1 MINK CREEK MINIMUM FLOW

Twin Lakes proposes to bypass water at its Mink Creek diversion dam as needed to maintain a year-round 10 cfs flow in Mink Creek. The effects of a new minimum flow requirement would be felt mainly during summer and early fall, boosting the average summer flow in Mink Creek from approximately 7 to 13.2 cfs[4] (Figure E7-29). A frequency plot of the flows under the Base Case and Mink Creek mitigation scenarios are shown in Figure E7-30. Under the Base Case more than 80% of the flows during summer are modeled to be less than 10 cfs, 70% are less than 5 cfs, and 30% are less than 1 cfs.

[4] Figures E7-29 and E7-30 are based on synthetic hydrology data developed under Study 5 (see Appendix D). Work performed by Ecosystem Sciences during 2013 (Appendix B) confirms that Mink Creek is overall a gaining stream so that the lower reaches contain a small amount of flow even when flow is zero at the Twin Lakes Diversion.

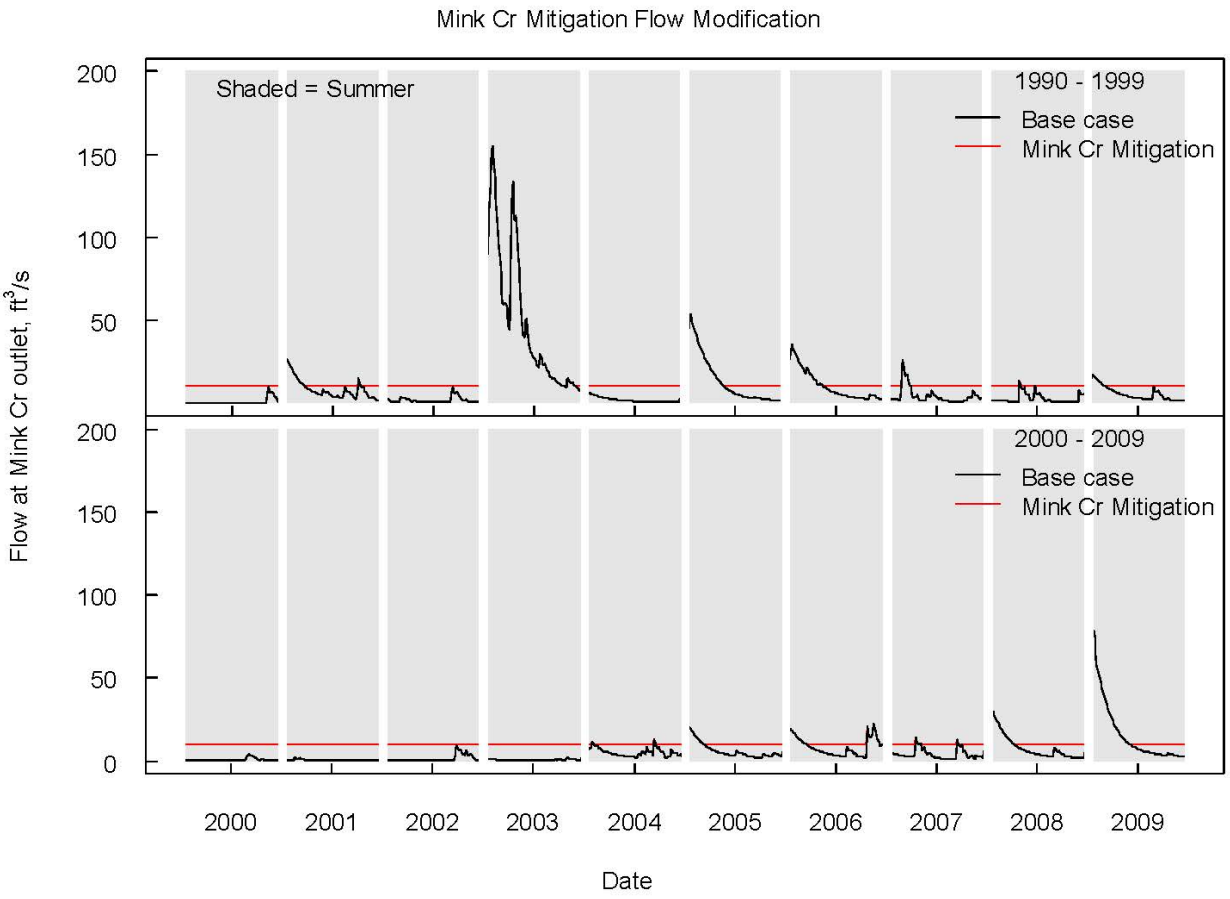


Figure E7-29. Compilation showing estimated historic summer flows in Mink Creek in comparison to the proposed minimum 10 cfs flow.

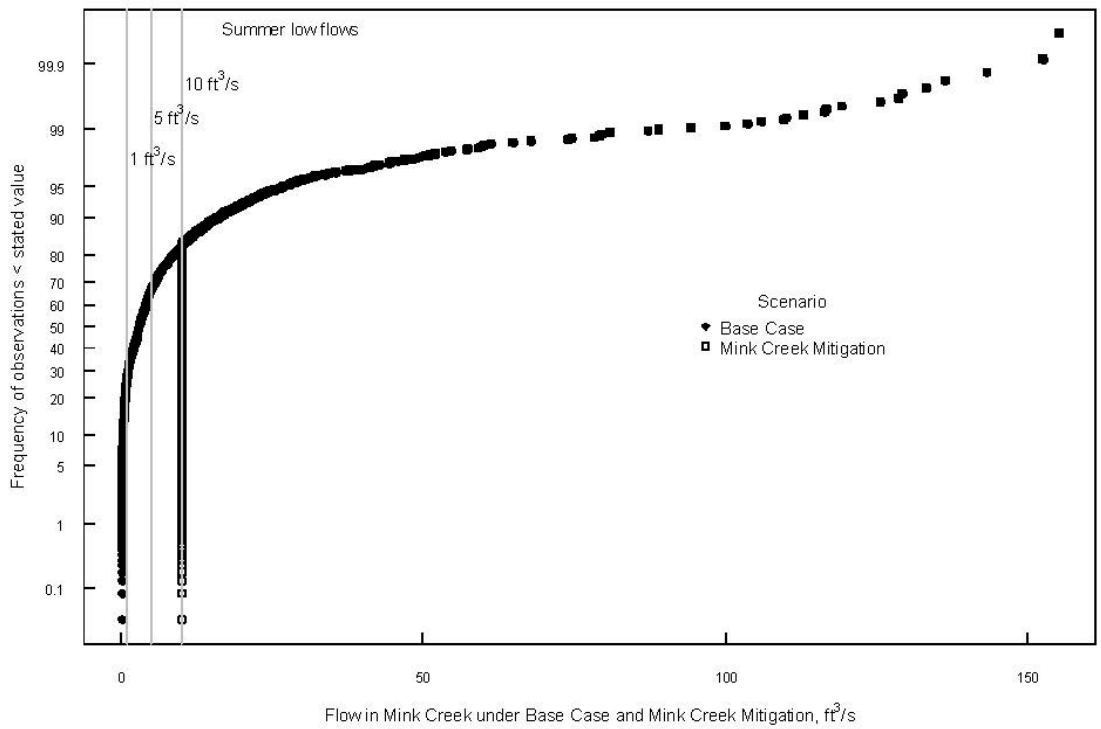


Figure E7-30. Frequency plot of summer flows for Base Case and Mink Creek mitigation scenarios.

As seen in Tables E7-5 and E7-6, temperatures in Mink Creek during the 2009 study period ranged from near freezing to a maximum of 15.4°C, while the historical data showed a lower median temperature but a larger upper end of the range. All of the historical and project temperature data from Mink Creek show that cold water aquatic life is fully supported with regard to temperature, while the standard for salmonid spawning is not fully supported due to some instantaneous summer measurements greater than 13°C.

Increasing the flows has two general effects on temperature. First, the increased flow will tend to increase velocity and reduce travel time from the diversion to the confluence with the Bear River near Riverdale, a distance of approximately 8 mi. This reduced travel time allows less time for the flow to absorb solar radiation and sensible heat from the surroundings and, thus, the temperature will increase less than under the lower flow base case scenario. In addition, the maintenance of the instream flow will deepen the water so that less sunlight strikes and warms the substrate and less heating will occur from below. The increased flow would also deepen the water in the channel somewhat while retaining the flow within existing banks. This will decrease the surface area:volume ratio in the stream. Since the heat inputs are across the air/water interface at the surface, the heat inputs would change little and the larger volume would absorb the heat with a smaller temperature rise. Although temperatures are likely to drop, the Mink Creek mitigation will improve conditions for coldwater fisheries in Mink Creek only marginally because Mink Creek already fully supports that use. Furthermore, the flow increment from Mink Creek into the Bear River estimated from the modeling is very small relative to the Bear River flow, only 1-2%.

Therefore any small reduction in Mink Creek temperature will be absorbed in the much larger Bear River with no measureable impact on the Bear River temperature.

Mink Creek mitigation will have a small beneficial impact on salmonid spawning suitability in Mink Creek for brown trout and rainbow/cutthroat trout. For rainbow and cutthroat trout, Mink Creek flows are normally well in excess of the 10 cfs during the April – June core spawning window[5] (see Figure E7-31). However, the Mink Creek minimum flow requirement could improve compliance with the salmonid temperature standard during low water years when Mink Creek flows are below 10 cfs during spawning and the water temperature often exceeds 13°C (see Figure E7-11a). For brown trout, increased instream flow may provide additional spawning habitat compared with existing conditions (Figure E7-32) but would provide no significant water temperature benefits because air and water temperatures during the October – December core spawning window[5] do not typically exceed the 13°C salmonid spawning standard (see Figure E7-11b).

Increased flow would also allow less time for streambed sediment to exert an oxygen demand, resulting in less DO depletion and higher oxygen levels. An influence similar to the reduced air surface area:volume ratio for temperature is seen as the substrate area:volume ratio decreases and a similar oxygen flux is taken from a larger volume resulting in less oxygen depletion. Since oxygen levels in Mink Creek are currently high and support water quality standards, the net impact of the 10 cfs instream flow would be small but beneficial nonetheless by eliminating the possibility that extreme low flow would create conditions of low dissolved oxygen.

[5] under some conditions rainbow and cutthroat trout spawning may extend into July and brown trout spawning may extend into January

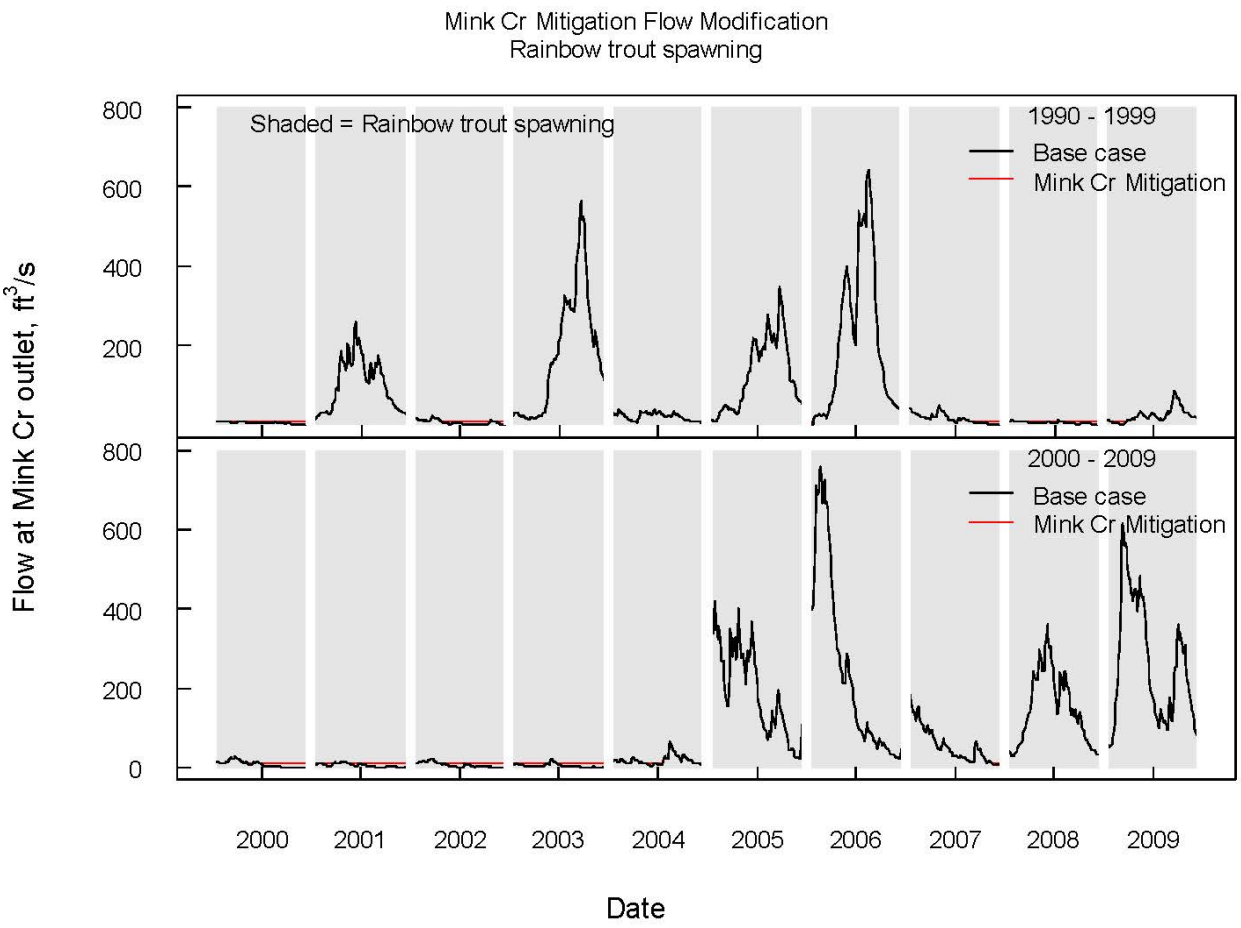


Figure E7-31. Flow scenario for Mink Creek Mitigation Plan for rainbow trout (provide a minimum flow of 10 cfs at Mink Cr Diversion). Unshaded gaps schematically represent the 9-month non-spawning period and are NOT TO SCALE.

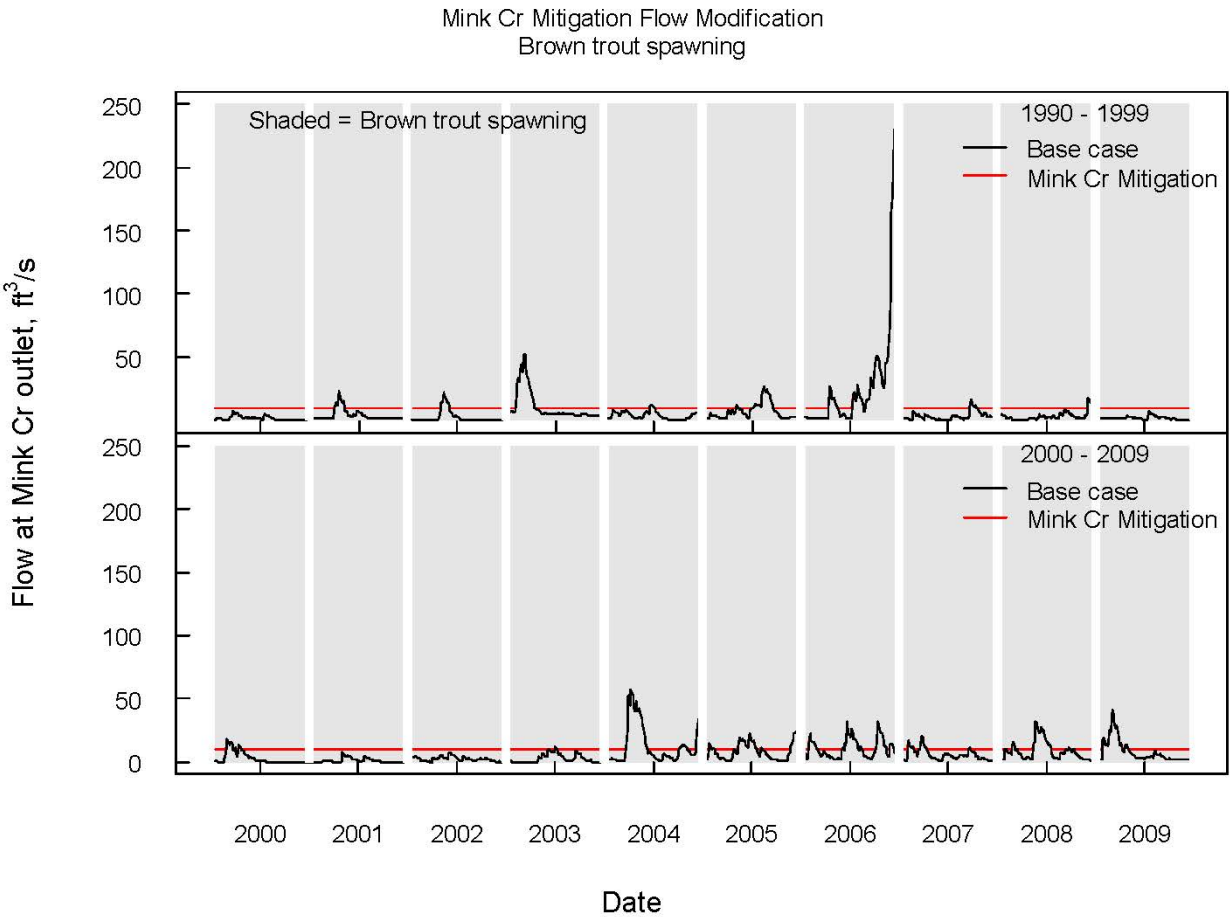


Figure E7-32. Flow scenario for Mink Creek Mitigation Plan for brown trout (provide a minimum flow of 10 cfs at Mink Cr Diversion). Unshaded gaps schematically represent the 9-month non-spawning period and are NOT TO SCALE.

7.4.2 DISSOLVED OXYGEN MANAGEMENT PLAN

Water quality modeling indicates that discharges from the project powerhouse could occasionally fail to comply with state water quality standards for waters below new hydroelectric projects (≥3.5 instantaneous, ≥ 4.7 7-day mean, ≥6.0 30-day mean) as was discussed in Section 7.3.3 above. To prevent non-compliance Twin Lakes would implement a two-stage Water Quality Management Plan whereby dissolved oxygen below the powerhouse discharge would be monitored and steps would be taken as needed to increase dissolved oxygen in order to comply with state standards. The first stage action would be to inject air into the powerhouse discharge within the turbine draft tubes. The second stage action would be to begin bypassing water past the turbines through the 48-in. fixed cone valve. This valve would eject water as a spray jet having a dissolved oxygen concentration close to saturation. Bypass water would be mixed with turbine discharge water as needed to obtain compliance with water quality standards at the downstream monitoring station. The draft Water Quality Management Plan is presented in Appendix B.

7.4.3 RE-REGULATING OF FLOW FLUCTUATIONS

By operating the project in the alternative manual mode (see Exhibit B), the new reservoir may be used to level out flow fluctuations from Oneida Dam. As an example, a 12-hour flow pulse of 500 cfs could be re-regulated by allowing the reservoir level to increase by about 1.1 ft over 12 hours, followed by a 12 hour period during which the extra water would be released. The water level change would reduce and increase the reservoir surface area by about 6.2 acres. This method could be used to release water from the new reservoir in a manner that averages the high and low flow levels, thus maintaining relatively continuous flow levels in the river downstream. The benefits to water quality and fishery conditions that would result from smoothing peak flow pulses include minimizing the following:

- Intermittent stream margin dewatering;
- Dewatering of redd sites;
- Substrate armoring;
- Sedimentation of redds;
- Mortality of emergent fry and juveniles due to fluctuating water velocities;
- Reduction of available trout habitat through fluctuating water depth, velocity and temperature.

This potential benefit of the project would be available for the long term and could be adapted for any type of flow fluctuation that might occur in the future. Regulation of flow fluctuations would allow Oneida Dam to achieve maximum power production by flow peaking without creating negative impacts on downstream ecosystems. The small, short period fluctuations in reservoir water elevation and surface area would not be expected to have any adverse effect on riparian and wetland health along the reservoir fringe.

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