1.0 INTRODUCTION

The objective of the Repair Historic Kennecott Mine Structures and Utilities Project is to repair a number of the historic Kennecott Mine structures and upgrade the utilities in the historic area owned by the National Park Service (NPS). This design narrative discusses Phase II of the project, which addresses water system repairs and upgrades by evaluating options for a code-compliant source of potable water and supplying water for fire suppression to serve the Kennecott National Historic Landmark.

1.1 Purpose and Need

According to the NPS Scope of Services The State of Alaska Department of Environmental Conservation (DEC) informed the park in November 2004, that due to past violations of water quality, the NPS is a candidate for the state's Significant Non-Compliant (SNC) List. The system currently operates on a waiver from DEC regulation. The system needs upgrade to be compliant with current surface water treatment regulations; state and federal. NPS staff have also expressed concerns about the quality of water from their existing source.

NPS owns 20 historic buildings as part of the Historic Kennecott Mine. With numerous historic timber framed structures at the mine, the installation of a fire suppression system is necessary for visitor safety and resource protection.

1.2 Project Scope

The replacement of the domestic water system and the addition of a fire suppression system will include the development of a water source, the construction of an intake structure, the installation of water storage tanks sufficient for the domestic water and fire suppression demands, construction of a treatment facility compliant with the DEC drinking water standards, and the construction of a distribution system to meet the domestic and fire suppression needs. Six buildings will receive fire suppression systems and three buildings will receive domestic water services.

Table 1: Buildings Receiving Fire Flow and Domestic Water

BUILDINGS	FIRE FLOW	DOMESTIC
Company Store	X	X
Power House	X	-
Machine Shop	X	-
Leaching Plant	X	-
Mill	X	-
Recreation Hall	X	-
New School (Lot 4)	-	X
Dairy Barn	-	X

2.0 WATER SYSTEM NARRATIVE

2.1 Water System History

The historical domestic water system had above grade segments and below grade segments of piping. Along sections of Copper River Road, the pipeline traveled through an above ground wooden utilidor. The water main was also visible as it traveled through the historic buildings of the mine.

2.2 Existing Conditions

2.2.1 National Creek Water System

The current source for the Kennecott Mine domestic water system is National Creek. The exiting treatment plant has a combined filtration and chlorination system and functions without power. The existing plant is very low production but is sufficient to meet NPS's demands.

2.2.2 Hydroelectric Water System

The historic source for the hydroelectric power plant is Bonanza Creek. The water was conveyed from the intake on Bonanza Creek to the power plant in a wooden penstock. There is currently no hydroelectric power generation at the mine.

2.2.3 Fire Suppression System

There is no existing fire suppression system at the mine. The historic fire suppression system at the mine consisted of hose houses (fire hydrants) fed by a water line along Copper River Road. This system no longer functions, but portions of the system are still present.

2.2.4 Operating Season

The Kennecott Mine is staffed from approximately mid-May through mid-October. The mine is open to visitors from Memorial Day to Labor Day. After its operating season, the mine is winterized.

2.2.5 Temperature

The following table shows the average and record highs and lows for the operating season at Kennecott Mine.

Table 2: Operating Season Temperatures

MONTH	AVERAGE HIGH (F)	RECORD HIGH (F)	AVERAGE LOW (F)	RECORD LOW (F)
May	60	80	30	-1
June	69	89	37	24
July	71	87	42	28
August	67	85	38	18
September	56	72	31	6
October	38	75	19	-22

2.3 Water Source

There are three potential sources for the domestic water system; groundwater wells, National Creek, and Bonanza Creek.

2.3.1 Groundwater Wells

The 2003 Utilities study reported soil conditions in Kennecott as not conducive for large production water wells. There are private wells in the area, among them are two owned by Kennecott lodge. According to the 2003 utility study, these two wells only produce about 2 gallons per minute (gpm).

2.3.2 National Creek

The existing domestic water source is National Creek. NPS staff have reported high turbidity levels in National Creek, leading to frequent filter changes by NPS staff. An intake structure on National Creek would require frequent maintenance due to the large amounts of sedimentation. NPS staff also report that National Creek has a history of flooding, which could lead to damage of the intake structure proposed for the new system.

2.3.3 Bonanza Creek

USGS information collected over the past 5 years indicates Bonanza Creek maintains baseline levels of around 3 cubic feet per second (ft^3/sec) during the park operating season. Seasonal variations can bring the total stream flow up to above 30 cfs and down to approximately 0.5cfs.

2.3.4 Source Recommendation

Bonanza Creek is our recommended water source for the following reasons:

- Previous reports state groundwater wells will not provide adequate flow to serve NPS demands.
- The National Creek intake location would have to be 3,600 feet up the National Creek drainage basin to reach the required elevation of 2,520 feet.
- Bonanza Creek intake is located 3,400 feet from Copper River Road and would provide the required head for the fire suppression system, domestic water system, and potentially hydroelectric power production.
- The Bonanza Creek intake location is accessible by the Portal Trail. National Creek is not as accessible by comparison.
- Piping from the Bonanza Creek intake structure to the Kennecott Mine can follow the Portal Trail minimizing disturbance,
- NPS staff and the 2003 Utilities study have reported Bonanza Creek water is high quality.
- The water quality tests, completed by Northern Test Labs in 2001, for Bonanza Creek show low levels of total dissolved solids and low levels of heavy metals.

2.4 Water System Environmental Regulations

2.4.1 Surface Water Treatment Rule

This system is considered Transient Non-Community (TNC) because it serves less than 25 people for less than 6 months of the year. TNC systems are the least regulated of the classifications. Because the water system has used and will use a creek as the water source, the Public Water System (PWS) must comply with the Environmental Protection Agency (EPA)'s 1989 Surface Water Treatment Rule. The Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) will require the following removals:

CONTAMINANT	LOG REMOVAL	% REMOVAL
Giardia	3-Log	99.9
Viruses	4-Log	99.99
Cryptosporidium	2-Log	99

Additional requirements to LT2ESWTR include:

- Treated water turbidity must be equal or less than 0.5 NTU in at least 95% of measurements, taken each month.

- The disinfectant (chlorine) residual concentration in water entering the distribution system cannot be less than 0.2 mg/L for more than four hours during periods when the system is in service (unless the DEC determines the failure to be due to unusual or unpredictable circumstances).

2.5 Water Demand

2.5.1 Domestic Water Demand

From NPS statistics for the Historic Kennecott Mine approximately 12,000 people visited the mine annually in 2010 and 2011. The peak use month of July accounted for over 4,000 of those visits in both 2010 and 2011.

Table 3: Kennecott Mine Visitation Trends

NPS STATISTICS	
JULY 2010 VISITORS	**JULY 2011 VISITORS**
4,566	4,273
TOTAL 2010 VISITORS	**TOTAL 2011 VISITORS**
11,186	10,754

The domestic water system currently being designed provides water to only three of the NPS structures; the General Store, the New School, and the Dairy Barn. These structures do not contain bathroom and public facilities for park visitors, only park staff.

Table 4: Peak Domestic Demand

STRUCTURE	DOMESTIC FACILITIES	FACILITY USERS	PEAK DAILY WATER USE (GAL) **
Dairy Barn	Restrooms, Potable	Staff (10 at 15 gpu)	150
Staff Bath House (on dairy barn premises)	2 Restrooms, 2 Showers, Washer, Dryer, Kitchen, Potable	Staff (6 at 100 gpu)	600
New School	2 Restrooms, Potable	Staff/Public (100 at 3 gpu)	300
Store	Restrooms, Potable	Staff/Public (200 at 3 gpu)	600
		Peak Total Daily Demand (gal)	**1,650**
		Peak Hour Demand (gal)*	**275**
		Peak Flow (gpm)	**4.6**

* For the peak hour demand a peak hour factor of 4.0 was used. (Peak Hour Demand = Peak Total Daily Demand/24 hours*4.0)
** The peak daily water use was estimated from the number of fixtures, the number of users, and the estimated gallons per use (gpu) for the facilities.

If future developments occur at the mine, the peak demands on the domestic water system will be considerably higher than the current design demand calculated. To calculate future peak daily flows the assumed maximum population at the mine is 400 daytime visitors with 60 overnight guests and 10 full time staff, resulting in an 8,450 gallons per day (gpd) demand. Using a peak hour factor of 4, the peak hour flow is estimated to be 23 gpm. This demand accounts for the bunkhouse being developed to accommodate 60 guests, the cottages being developed into staff housing, and all visitors to the park using the NPS domestic water facilities.

Table 5: Projected Domestic Demand

USER CATEGORY	PEAK NO. OF PEOPLE*	PEAK DAILY WATER USE (GAL)	TOTAL PEAK DAILY WATER USE (GAL)
Overnight Guests	60	70	4,200
Daytime Visitors	400	6	2,400
Kennecott Staff	10	160	1,600
		Peak Total Daily Demand (gal)	**8,200**
		Peak Hour Demand (gal)**	**1,367**
		Peak Flow (gpm)	**22.8**

* For the peak visitation day in July, it was estimated that there are 400 daytime visitors to the Kennecott Mine and there are 60 overnight visitors. These numbers were estimated from the 4,566 and 4,273 visitors to the Kennecott Mine in July 2010 and July 2011 respectively (visitation numbers are from the NPS public use statistics office)
** For the peak hour demand a peak hour factor of 4.0 was used. (Peak Hour Demand = Peak Total Daily Demand/24 hours*4.0)

Despite a calculated peak demand of 4.6 gpm (as shown in Table 4), the water treatment and distribution system will be designed to supply 23 gpm (as shown in Table 5) to accommodate potential future demands. A 23 gpm system with a 12,000-gallon contact time (CT) tank will meet current and anticipated future demands.

2.5.2 Fire Suppression Demand

The leaching plant requires the largest fire suppression flow at 2,000 gpm. The fire suppression demand is based on the 2,000 gpm flow for 60 minutes resulting in a total demand of 120,000 gallons.

2.6 Water Storage

2.6.1 Reservoir

The proposed location of the water reservoir is NPS owned Lot 8. This lot is accessible by the Portal Trail.

A welded steel or bolted steel tank is typical for reservoirs of this size. The erection costs for a prefabricated bolted steel tank are lower than that for a welded tank given the limited access. Bolted steel tanks are easier to erect where large cranes cannot be used in the tank installation. Bolted steel tanks come in smaller panels, than welded tanks and do not require welding equipment for assembly. The proposed location of the water reservoir is accessible only by the Portal Trail and therefore a bolted steel tank is recommended. Despite holding raw surface water from Bonanza Creek, it is still recommended that the water reservoir be covered. Covering the tank will prevent animals and humans from further contaminating the water source.

In addition to providing fire flow storage, this large tank could be incorporated into the water system layout to function as a settling tank. Decreasing the amount of sediment entering the water treatment plant the will reduce operation and maintenance costs. Sediment in the reservoir would be flushed at the end of each year.

2.6.3 Contact Time Tank

As estimated in Table 4, the existing domestic water demand is 1,650 gpd during the peak July day. Due to the very low domestic demand for the proposed system and a consistent water source (large water reservoir) the CT tank should be sized at 10,000 gallons. A 20 gpm treatment system could fill a 10,000-gallon CT tank in 8 hours and 20 minutes. With the estimated peak daily demand of 1,650 gpd a 10,000-gallon CT tank would supply the Kennecott Mine for over 6 peak use days without needing to be refilled by the treatment plant.

At a continuous demand of 20 gpm a 10,000-gallon CT tank would provide sufficient contact time to the chlorine treated water prior to it reaching the distribution system on Copper River Road. If the tank is sized too large stagnant water could become an issue with very low turnover rates during slow parts of the season. The proposed location of the CT tank is on the top of the NPS owned Lot 74. This lot is accessible by the Portal Trail.

Tank materials considered for the CT tank include polyethylene or steel. A polyethylene tank is recommended due to low material cost and a low installation cost in comparison to a steel tank of this size. Polyethylene tanks are manufactured to provide a high durability and a long design life.

Located along the Portal Trail and in close proximity to the historic mine structures, the proposed CT tank and water treatment plant will have to blend with the historic character of the mine. The design of the water treatment plant structure and the possible construction of a structure around the CT tank can incorporate the new developments into the historic area.

2.7 Water Piping And Distribution

2.7.1 Fire Suppression System

With nearly 500' of head from Bonanza Creek to Copper River Road street level, the water system design can accommodate any reasonable pressure requested in the fire suppression design. One of the fire suppression alternatives requires 165 psi pressure in front of the Mill Building, street level, for exposure suppression systems. This requirement could be met by placing the fire suppression tank at a minimum elevation of 2,340 feet. Fire suppression flow would be delivered to the Mill building first and then the pressure could be reduced through a series of pressure reducing valves before being distributed to the other facilities requiring fire flow at a much lower pressure.

There are existing hose houses along Copper River Road. New hose houses will be placed in the same locations, and follow the same general design concept, to mimic what has been done historically.

2.7.2 Domestic Water System

Locating the CT tank on Lot 74 would provide the desired water pressures to the three structures requiring domestic water and any future structures along Copper River Road. The water pressure at the bottom of the Dairy Barn (the lowest structure receiving domestic water is at an elevation of 1960 feet) would be 82 psi. The water pressure on the upper floor of the New School House (highest structure receiving domestic water 2015') would be 60 psi.

The high pressures provided along the proposed Copper River Road water main would allow for structures to the east of the road to be served in the future without pumping.

Table 6: Domestic Water Pressures

DOMESTIC	WATER PRESSURE
Desired psi of domestic water services (psi)	40-80
elevation of Lot 74 (ft)	2070 - 2160
CT tank elevation (ft)	2155
elevation of highest structure (top of school house)	2015
water pressure lowest (psi)	**60**
elevation of lowest structure (bottom of dairy barn)	1965
water pressure highest (psi)	**82**

2.7.2 Pipe Material

To preserve the historic nature of the Kennecott Mine it is recommended that the piping consist of buried high-density polyethylene (HDPE) main whenever possible. Inactive historic piping should be left visible, and the wooden utilidor along Copper River Road should be restored in certain locations to preserve the historic nature of the mine. Areas where above grade piping is necessary an alternative pipe material can be used or the HDPE main can be hidden inside of an existing wood stave pipe, wooden utilidor, or larger diameter historic pipe.

2.7.3 Pipe Alignment

To reduce costs and disturbance to the Kennecott area the new transmission line from the intake at Bonanza Creek to the CT tank on Lot 74 would follow the same route as the old wooden penstock, which traveled along Portal Trail conveying water from Bonanza Creek to the old hydroelectric plant. This route keeps the transmission line on NPS property. Geotechnical investigations will need to be performed to ensure that the pipe can be buried at a depth that allows for appropriate cover. If a hydroelectric plant is proposed the intake structure and transmission line should be properly sized to provide for the fire suppression, domestic water, and power plant demands.

2.9 Water Treatment

At this pre-design level, we envision the treatment system to have the following components:

- *Basket Strainers* - Provides removal of large particles that do not settle out in the fire-flow tank (assuming selection of Alternative 1, as discussed below).
- *50 Micron Filters* - Provides removal of small particles, and large viruses. This filter will also protect the filter downstream of it, which will be more susceptible to fouling.
- *1 Micron Filter* - Provides removal of Giardia and Cryptosporidium
- *Caustic Soda Addition* - Balances the pH, and reduces corrosion potential.
- *Chlorination* - Provides chlorine residual to protect against future recontamination. Proportional feed chemical injector pump using either a powered pump, or a water drive pump assuming the design parameters stipulate no power.
- *Contact Time Tank* - Following chlorination, the water will go to a treated water storage tank. This will be sized so that adequate chlorine contact time elapses prior to the treated water distribution. Adequate chlorine contact time is required for proper disinfection.

Other treatment system features will include:

- *Redundant filter trains* - Two filter trains are recommended, allowing one train to remain in use while the other is being repaired. Cleaning and switching out filters will be a regular occurrence, and redundancy will allow for continuous system operation.
- *Monitoring/Sampling Taps* - Installation of a sampling tap prior to filtration to monitor incoming influent quality and a sampling tap following treatment operations to monitor treated water quality before the water enters the chlorine contact tank.
- *pH, Temperature, and Turbidity Monitoring devices* - The water treatment system will be equipped with devices for monitoring pH, temperature, and turbidity. It is required that these characteristics be monitored and reported to the DEC.
- *Pressure Gauge* - Installation of pressure gauges upstream and downstream of the filter trains to monitor the pressure differential across the filters. A predetermined differential in the pressure gauges will alert NPS staff to change the filters.

2.10 Winter Shutdown and Maintenance

Following the Historical Kennecott Mine Tourist season (mid-October) the domestic water and fire suppression distribution systems and tanks will be drained to prevent the pipes from bursting in the winter. A valve will be located at the intake structure to stop all flow from entering the system from Bonanza Creek. A drainage valve will have to be located at the lowest point on the domestic and fire suppression distribution systems to allow for complete draining. Once the reservoir is drained it will require flushing to remove any sediment that has settled at the bottom of the tank. The CT tank should also have all sediment removed and be cleaned at the end of the season. Through this process the domestic and fire suppression systems will be functional when the historic mine opens up again at the start of the tourist season. The domestic water system will require disinfecting each spring before it is back in operation. The reservoir and CT tank will require filling every year prior to the start-up of the PWS. The CT Tank and all potable water distribution mains will require disinfection during start-up in accordance with DEC regulations.

3.0 WATER SYSTEM PROPOSED ALTERNATIVES

3.1 Alternative 1 – Separate Domestic and Fire Suppression Distribution

Alternative 1 consists of separate fire suppression and domestic water distribution systems (Figures 1 and 2). The fire suppression and domestic water systems share the same 8-inch HDPE piping from the intake at Bonanza Creek to the reservoir on Lot 8 and to the water treatment plant on Lot 74. After the domestic water is treated, it is stored in a 10,000-gallon treated water tank on Lot 74. From the treatment plant the 8-inch fire suppression main carrying untreated water and the 4-inch domestic water main carrying treated water share the same trench as they distribute water to the structures of the Historic Kennecott Mine.

Alternative 1 Consists of:

- Intake structure at Bonanza Creek (top of NPS Lot 50),
- Construction of 2,650 feet of 4-inch HDPE water main,
- Construction of 6,150 feet of 8-inch HDPE water main,
- 20 gpm capacity water treatment plant located on Lot 74,
- 120,000-gallon raw water storage reservoir on Lot 8, and
- 10,000-gallon treated water tank on Lot 74.

Table 7: Pipe Lengths Alternative 1

Alternative 1		
Pipe Segment	4” HDPE	8” HDPE
Intake to Reservoir	-	2,200
Reservoir to Treatment Plant	-	1,500
CT Tank/Treatment Plant to Copper River Road	450	500
Copper River Road Main	1,950	1,950
Dairy Barn Main	250	-
Total	**2,650**	**6,150**

Disadvantages to Alternative 1:

- Higher capital cost due to separate domestic and fire suppression distribution systems and two independent tanks.

Advantages to Alternative 1:

- Lower treatment costs because there is no need to treat the 120,000 gallons of fire suppression water on an annual basis.
- Lower risk of stagnation of potable water with a smaller separate treated water tank and piping system.
- A domestic water tank on Lot 74 allows for water distribution without the use of pressure reducing valves.

3.2 Alternative 2 – Combined Domestic And Fire Suppression Distribution

Alternative 2 consists of a combined fire suppression and domestic water distribution system (Figures 3 and 4). The fire suppression and domestic water systems share the same 8-inch HDPE piping from the intake at Bonanza Creek to the water treatment plant and 120,000-gallon reservoir on Lot 8. After the fire suppression and domestic water is treated it is stored in the 120,000-gallon reservoir on Lot 8. From the reservoir the domestic and fire suppression water is distributed to the structures of the Historic Kennecott Mine in one 8-inch main.

Alternative 2 Consists of:

- Intake structure at Bonanza Creek (top of NPS Lot 50),
- Construction of 360 feet of 4-inch HDPE water main,
- Construction of 5,900 feet of 8-inch HDPE water main,
- 20 gpm water treatment plant located on Lot 8, and
- 120,000 gallon treated water storage reservoir on Lot 8.

Table 8: Pipe Lengths Alternative 1

Alternative 2		
Pipe Segment	4” HDPE	8” HDPE
Intake to Treatment Plant	-	2,000
CT Tank to Copper River Road	-	2,100
Copper River Road Main	-	1,950
Dairy Barn Main	250	-
Total	**250**	**6,050**

Disadvantages to Alternative 2:

- Water in tank would have very low turnover rate under normal operating circumstances, resulting in potential for disinfectant by-products and stagnant water. Possibly not allowable by the DEC.

- An additional treatment step for the removal of sediment may need to be incorporated into the system.

- It takes over 4 days to fill the 120,000-gallon reservoir with treated water at 20 gpm.

Advantages to Alternative 2:

- Lower capital cost because only one tank and one distribution system.

3.3 Existing Water System Alternatives

The existing water intake, treatment, and distribution system can be abandoned in place, kept on-line as a backup system, or demolished and removed from the park. If the existing water treatment plant were kept on-line as a backup system the operation and maintenance costs would be significantly greater for the Kennecott Mine domestic water system. The very low domestic demand of the proposed structures makes having two operating water treatment systems not economically practical. The recommended option is to demolish and remove the above grade sections of the existing domestic water system and abandon the below grade sections in place. All historic sections of the water distribution system should be preserved.

4.0 ADDITIONAL INFORMATION AND RECOMMENDATIONS

4.1 Fieldwork

Prior to beginning design on any of the alternatives, it is recommended NPS complete the following fieldwork investigations:

1. The 2001 Bonanza Creek water quality tests did reveal a low langelier index (-0.700 at 10 degrees C), which would results in high corrosion potential. In the early stages of design, we recommend a thorough water quality analysis be completed. The following components should be tested for:

   - Total Dissolved Solids (TDS)
   - Total Suspended Solids (TSS)
   - Total Organic Carbon (TOC)
   - Heavy Metals
   - Nitrates

   Water quality should be measured in spring time and again at a point near peak-season, sometime in July.

2. Water quality analysis on National Creek. Poor water quality has been reported in National Creek, but as a step of due diligence we recommend the same water quality analysis done on Bonanza Creek, be done on National Creek.

3. Geotechnical investigation along Portal Trail to ensure the transmission line will have required cover and geotechnical investigation at proposed tank locations.

4.2 Hydroelectric Considerations

Bonanza Creek could potentially be used for hydroelectric power generation. Either of the water system design alternatives could be upgraded to account for future development of the hydroelectric power generation, by upsizing the water lines running from Bonanza Creek down to the mine. At this time the 50% schematic alternatives do not account for hydroelectric development.

5.0 REFERENCES

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"Scope of Services, PMIS 159092- Repair Historic Kennecott Mine Structures and Utilities, Phase II- Water System Repairs and Upgrades."

DOWL FILE No: 234-32

SCRIPT FILE: N/A

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BONANZA CREEK INTAKE STRUCTURE ELEV=2,500'

8" HDPE

BONANZA CREEK

FIRE FLOW RESERVOIR
ELEV=2,340'
APP. 120,000 GALLONS

8" HDPE

WATER TREATMENT PLANT
APP. 10'X10'

8" HDPE

CT TANK
ELEV=2,155'
APP. 12,000 GALLONS

4" HDPE

TOP OF MILL
ELEV=2,190'

TRAM LINES

TRAM LINES

NATIONAL CREEK

NORTH GLACIER TRAIL

COPPER RIVER ROADBED

INDEPENDENCE TRAIL

PORTAL TRAIL

BUCKET TRAIL

STOPE TRAIL

BLACK POWDER TRAIL

NATIONAL CREEK WAY

THE TAILINGS

LEGEND

- PRIVATE LOTS
- RAW WATER
- TREATED WATER
- SPRINKLER SYSTEM
- DOMESTIC SERVICE

200 0 200 400

DESIGNED: CAN CADD RDL TECH. REVIEW: ARC DATE: X/X/2011	SUB SHEET NO. FIG-1	TITLE OF SHEET WATER SUPPLY ALTERNATIVE #1 50% SCHEMATIC REPAIR HISTORIC KENNECOTT MINE STRUCTURES AND UTILITIES WRANGELL-ST ELIAS NATIONAL PARK AND PRESERVE	DRAWING NO. 190 80,131 PMIS/PKG NO. 89431 SHEET ___ OF XX

DOWL FILE No: 234-32

SCRIPT FILE: N/A

8" HDPE

PORTAL TRAIL

TRAIL

WATER TREATMENT PLANT
APP. 10'X10'

8" HDPE

4" HDPE

CT TANK
ELEV=2,155'
APP. 12,000 GALLONS

TOP OF MILL
ELEV=2,190'

MILL
BUILDING

NATIONAL CREEK WAY

4" HDPE

8" HDPE

LEACHING PLANT

POWER HOUSE

MACHINE SHOP

COPPER RIVER ROAD BED

FINE TAILINGS

NATIONAL CREEK

STORE

SCHOOL

RECREATION HALL

DAIRY BARN

SILK STOCKING LOOP

JUMBO

SOUTH GLACIER TRAIL

LEGEND

- PRIVATE LOTS
- RAW WATER
- TREATED WATER
- SPRINKLER SYSTEM
- DOMESTIC SERVICE

100 0 100 200

DESIGNED: CAN DRAWN: RDL TECH. REVIEW: ARC DATE: X/X/2011	SUB SHEET NO. FIG-2	TITLE OF SHEET WATER SUPPLY ALTERNATIVE #1 50% SCHEMATIC REPAIR HISTORIC KENNECOTT MINE STRUCTURES AND UTILITIES WRANGELL-ST ELIAS NATIONAL PARK AND PRESERVE	DRAWING NO. 190 80,131 PMIS/PKG NO. 89431 SHEET ___ OF XX

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BONANZA CREEK INTAKE STRUCTURE ELEV=2,500'

8" HDPE

BONANZA CREEK

WATER TREATMENT PLANT APP. 10'X10'

FIRE FLOW RESERVOIR ELEV=2,340' APP. 120,000 GALLONS

8" HDPE

8" HDPE

TOP OF MILL ELEV=2,190'

TRAM LINES

TRAM LINES

NATIONAL CREEK

NORTH GLACIER TRAIL

COPPER RIVER ROADBED

INDEPENDENCE TRAIL

PORTAL TRAIL

BUCKET TRAIL

STOPE TRAIL

BLACK POWDER TRAIL

NATIONAL CREEK WAY

LEGEND

- PRIVATE LOTS
- RAW WATER
- TREATED WATER
- SPRINKLER SYSTEM
- DOMESTIC SERVICE

200 0 200 400

DESIGNED: CAN DRAWN: RDL TECH. REVIEW: ARC DATE: X/X/2011	SUB SHEET NO. FIG-3	TITLE OF SHEET WATER SUPPLY ALTERNATIVE #2 50% SCHEMATIC REPAIR HISTORIC KENNECOTT MINE STRUCTURES AND UTILITIES WRANGELL-ST ELIAS NATIONAL PARK AND PRESERVE	DRAWING NO. 190 80,131 PMIS/PKG NO. 89431 SHEET ___ OF XX

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TRAM LINES

TOP OF MILL
ELEV=2,190'

MILL
BUILDING

8" HDPE

8" HDPE

8" HDPE

PORTAL TRAIL

TRAIL

NATIONAL CREEK WAY

SILK STOCKING LOOP

JUMBO

COPPER RIVER ROAD BED

POWER HOUSE

MACHINE SHOP

LEACHING PLANT

SCHOOL

STORE

RECREATION HALL

SOUTH GLACIER TRAIL

DAIRY BARN

FINE TAILINGS

NATIONAL CREEK

LEGEND

- PRIVATE LOTS
- RAW WATER
- TREATED WATER
- SPRINKLER SYSTEM
- DOMESTIC SERVICE

100 0 100 200

DESIGNED: CAN DRAWN: RDL TECH. REVIEW: ARC DATE: X/X/2011	SUB SHEET NO. FIG-4	TITLE OF SHEET WATER SUPPLY ALTERNATIVE #2 50% SCHEMATIC REPAIR HISTORIC KENNECOTT MINE STRUCTURES AND UTILITIES WRANGELL-ST ELIAS NATIONAL PARK AND PRESERVE	DRAWING NO. 190 80,131 PMIS/PKG NO. 89431 SHEET ___ OF XX

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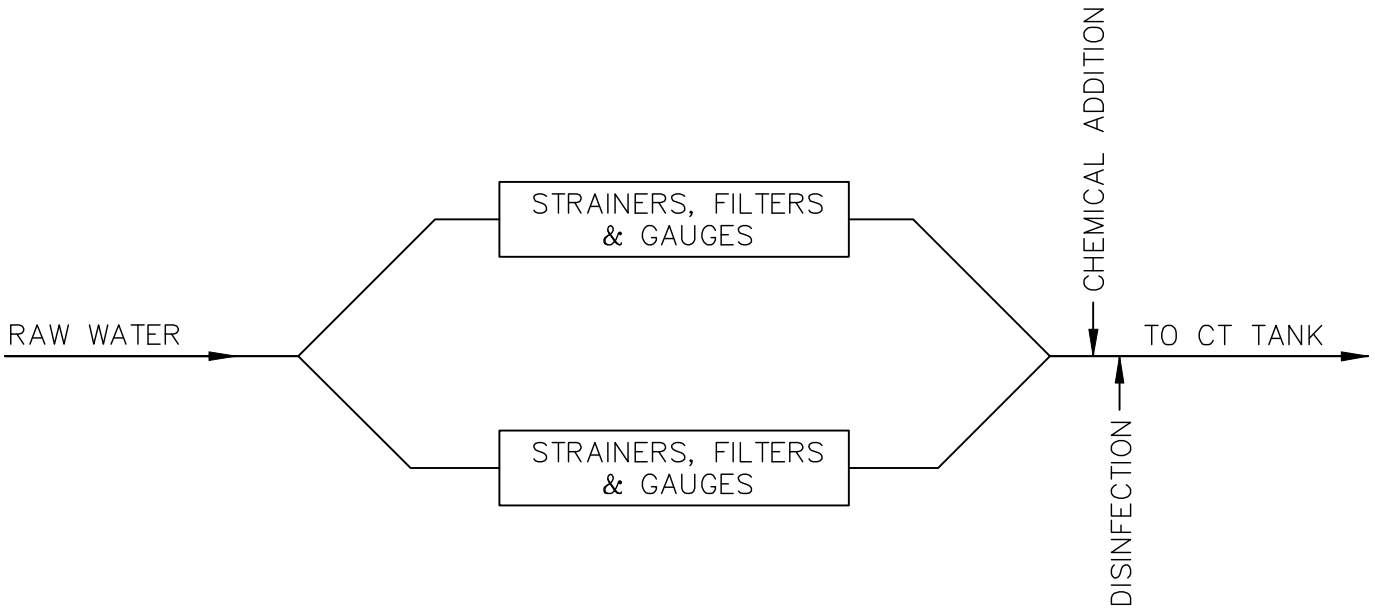

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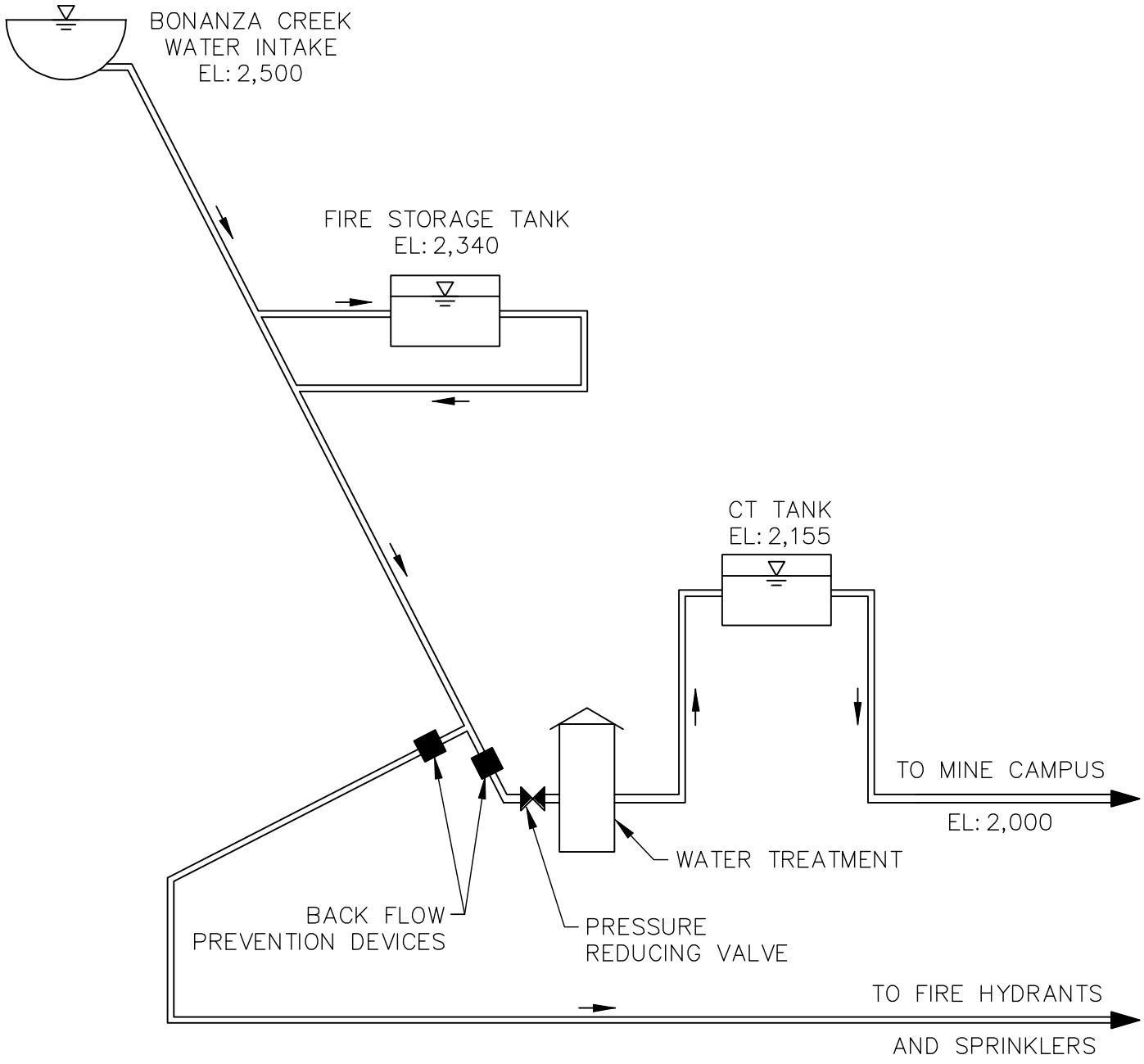
DESIGNED: CAN CADD: RDL TECH. REVIEW: ARC DATE: X/X/2011	SUB SHEET NO. FIG-5	TITLE OF SHEET WATER TREATMENT 50% SCHEMATIC REPAIR HISTORIC KENNECOTT MINE STRUCTURES AND UTILITIES WRANGELL-ST ELIAS NATIONAL PARK AND PRESERVE	DRAWING NO. 190 80,131 PMIS/PKG NO. 89431 SHEET ____ OF XX



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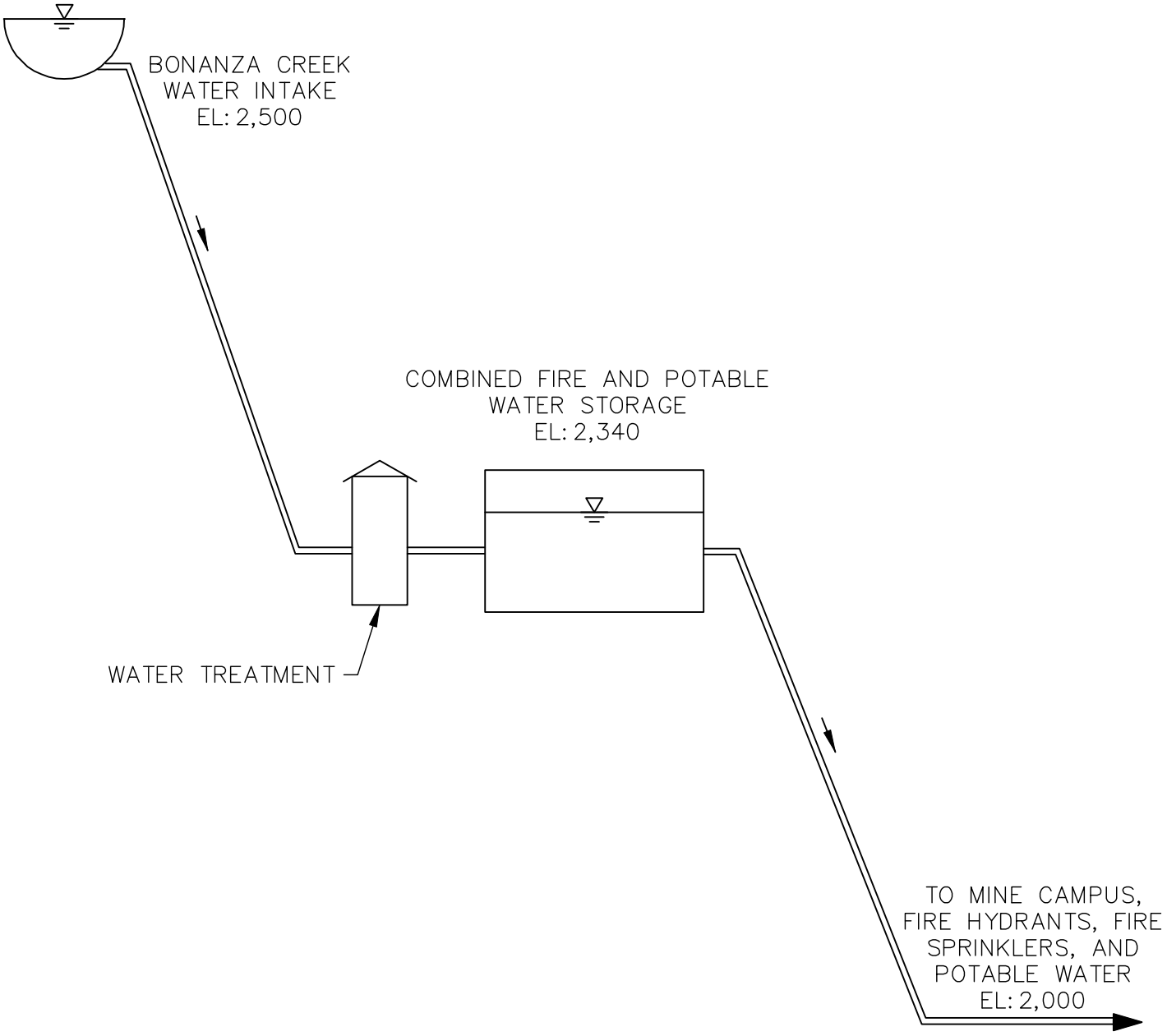
DESIGNED: CAN CADD: RDL TECH. REVIEW: ARC DATE: X/X/2011	SUB SHEET NO. FIG-6	TITLE OF SHEET WATER SUPPLY SYSTEM ALTERNATIVE #1 50% SCHEMATIC REPAIR HISTORIC KENNECOTT MINE STRUCTURES AND UTILITIES WRANGELL-ST ELIAS NATIONAL PARK AND PRESERVE	DRAWING NO. 190 80,131 PMIS/PKG NO. 89431 SHEET ____ OF XX



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DESIGNED: CAN CADD: RDL TECH. REVIEW: ARC DATE: X/X/2011	SUB SHEET NO. FIG-7	TITLE OF SHEET WATER SUPPLY SYSTEM ALTERNATIVE #2 50% SCHEMATIC REPAIR HISTORIC KENNECOTT MINE STRUCTURES AND UTILITIES WRANGELL-ST ELIAS NATIONAL PARK AND PRESERVE	DRAWING NO. 190 80,131 PMIS/PKG NO. 89431 SHEET ____ OF XX