AN INVESTIGATION OF ENERGY AND WATER USE AT SLIDE ROCK STATE PARK, ARIZONA

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Background

Due to their often remote locations, Arizona State Parks frequently have unique challenges in supplying clean drinking water and treating wastewater. Slide Rock State Park in Oak Creek Canyon, Arizona, typifies this situation. The Arizona Water Institute (AWI) sponsored a study to develop a best practices guide for increasing efficiency and decreasing the overall energy and water use of rural Arizona's water and wastewater systems and to identify those best practices appropriate for selected small systems through a series of case studies. Slide Rock State Park is located 21 miles south of Flagstaff and 6 miles north of Sedona along Highway 89A on a historic homestead and apple orchard. The historic homestead used a (now dilapidated and unused) flume to bring water from a higher elevation along Oak Creek to an orchard, which still exists and is now within the Park. The State Park continues the tradition of growing apples; so in addition to supplying clean drinking water to 240,000 visitors each year, the orchard is also irrigated as a part of Park operations.

WATER SUPPLY, TRANSMISSION, TREATMENT, STORAGE & DISTRIBUTION

Figure 1: Slide Rock State Park in Oak Creek Canyon, AZ

Raw water is drawn from Oak Creek, approximately 40 feet below and nearly 750 feet south of the Park's water treatment facility. There are two submersible pumps at the creek, installed near the low-flow water surface, that draw surface water from the creek. Screens on the intakes exclude debris. One pump delivers water to the drinking water treatment plant, and the other supplies untreated water for irrigation. The irrigation pump runs once a week for 24 hours between May-September and once or twice for 24 hours in October. Water intended for potable use is pumped to a package treatment facility, which provides for: chlorination using sodium hypochlorite, alum addition, and filtration. From the filtration/clarification system, the treated water goes into a 40,000 gallon ground-set steel tank, which has enough capacity for the entire winter, but only enough for a month or so in summer. The filtration / clarification system operates at about 25-30 gallons per minute (gpm). This sand/carbon filter combination requires 1000 gallons of treated water for backwashing, the timing and / or pressure within the treatment system dictates when backwashing is required. The spent backwash water is used for irrigation of nearby apple trees. Occasionally, backwashing is needed when there is insufficient treated water in storage, requiring water to be hauled in from Flagstaff, 20 miles away.

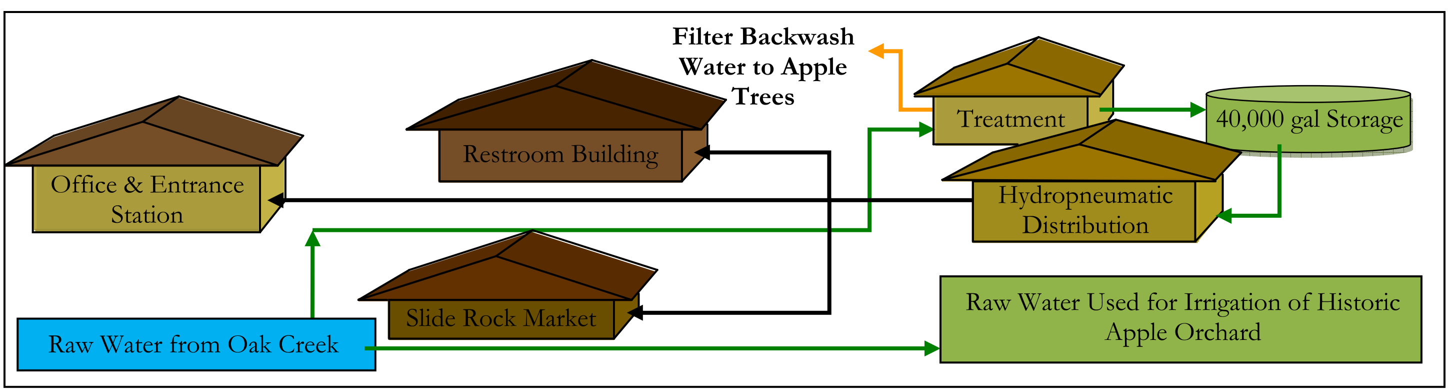

Figure 2: Water System at Slide Rock State Park, AZ

When needed, water is drawn from the storage tank by a booster pump, which is housed in an adjacent building. At that time, residual chlorine (sodium hypochlorite) is automatically monitored and adjusted as necessary. System pressurization is provided by the combination of the booster pump and a hydropneumatic tank, which handles low/nuisance demands. The pressurization system consists of a 500 gallon hydropneumatic tank, two 2 hp booster pumps, and an air compressor. Pressurized potable water is then distributed throughout the Park.

There is currently no wastewater treatment facility at Slide Rock State Park. Wastewater from the single restroom building west of Oak Creek is collected in a holding tank and pumped out 2 or 3 times a year. Gray water from hand washing is disposed of in a leach field adjacent to the restroom building. There is also a second restroom facility between Oak Creek and Highway 89A with a similar holding tank arrangement with removal twice a year.

SYSTEM METRICS

Water production and electricity usage data were collected from Slide Rock State Park and were used to estimate how much energy is used to treat and distribute a given volume of water. Three categories: potable water, irrigation water, and wastewater, were considered. The commonly used metrics of kWh/1000 gallons were developed for each category and tabulated in Table 1, below. The long distances involved in hauling wastewater yield an extremely high ratio of energy input (kWh) per volume (1000 gal) of wastewater.

Average Potable Demand	Average Irrigation Demand	Electricity Use-Potable	Electricity Use-Irrigation	Power Use-Wastewater	Annual Power Use-Water	Annual Power Use-Wastewater
215.5 kgal/year 590 gal/day 0.41 (gpm)	4.1 Mgal/year 11.2 kgal/day 7.75 gpm	5-7 kWh/kgal	~1 kWh/kgal	0 kWh/kgal, or 200-400 kWh/kgal accounting for truck hauling	$7,500-$9,500 per year	$12,000-$15,000 per year
Mgal=million gallons, kgal=thousand gallons, gpm=gallons per minute						

Table 1: Potable, Irrigation, and Wastewater Metrics at Slide Rock State Park

RECOMMENDATIONS/SUGGESTIONS

Best practices for consideration at Slide Rock State Park vary in their cost or effort of implementation.

NO OR MINIMAL COST

- Operate the backwash system in conjunction with the storage tank water level, allowing backwash to occur only when there is sufficient water to do so, even if it means backwashing before it may be required. This may result in extra occasional water and energy expenditures due to premature backwashing, but this will eliminate the need to haul, at great energy and financial expense, potable water from Flagstaff.
- Assess the costs of maintaining existing facilities versus upgrading over the expected life of the system.
- Review system plans, specifications, and records with plant operators, maintenance staff, and engineers before considering upgrades/improvements.
- Secure operations and maintenance guides and training for park staff when new systems/components are installed.
- Assess the balance between revenue and expenses.
- Understand how energy and water are utilized in the system.

LOW TO MODERATE COST

- Evaluate pumps and motors for upgrade to either high-efficiency or VFD. Due to the infrequent use of these system elements, unless one of these pieces of equipment is operating at extremely low efficiency, it would be advisable to upgrade only when equipment fails, or is near the end of its useful life.
- Implement a water conservation and education program.
- Develop a cost analysis and implement capital improvement planning.
- Retrofit facilities with energy efficient lighting, using high-efficiency ballasts and bulbs.
- Provide a primary clarifier (gravity-driven grit chamber) so the filtration system could operate for longer periods between backwashing cycles. A clarifier requires very little energy, and could save energy by reducing the need for backwashing, but requires significant capital investment.
- Perform a water loss/leakage survey.
- Evaluate off-peak power usage strategies.
- Adequately ventilate or sunshield all electrical and mechanical equipment in warm weather.

MODERATE TO HIGH COST

- Supply creek water via gravity flow from a higher elevation using a pipeline along the existing historic flume alignment. This would require about a mile of new pipe/flume.
- Consider additional system automation.
- Reduce friction/energy losses in pumps, fans, pipes, and valves.
- Build a wastewater treatment facility that generates high-quality effluent for use in irrigation.
- Utilize renewable energy wherever feasible.

CONTACT INFORMATION

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