NAVAJO PROJECT

OPERATION AND MAINTENANCE PLAN

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Table of Contents

Tables

Figures

Appendices

ACRONYMS AND ABBREVIATIONS

APS	Arizona Public Service Company
BART	Best Available Retrofit Technology
BC	Brine concentrator
BMPs	Best Management Practices
CESQG	Conditionally Exempt Small Quantity Generator
cf	cubic feet
CT	Cooling tower
EAP	Emergency Action Plan
EPA	U.S. Environmental Protection Agency ERP Emergency Response Plan
FGD	Flue-gas desulfurization
FIP	Federal implementation plan
GHG	Greenhouse gases
GWPP	Ground water protection plan
KM	Kayenta Mine
kV	Kilovolt
LADWP	Department of Water and Power of the City of Los Angeles
SOFA	Separated overfire air (burners)
MATS	Mercury and Air Toxics Standards
MPH	Miles per hour
MSS	Main Station Service
MW	Megawatts
MWh	Megawatt hours
NAAQS	National Ambient Air Quality Standards
NTUA	Navajo Tribal Utility Authority
NGS	Navajo Generating Station
NVE	Nevada Power Company
NOx	Nitrogen oxide
OSHA	Occupational Safety and Health Administration
OSMRE	Office of Surface Mining Reclamation and Enforcement
PCB	Polychlorinated biphenyls
PM	Particulate matter
PWCC	Peabody Western Coal Company
RCRA	Resource Conservation and Recovery Act
Reclamation	U.S. Bureau of Reclamation
ROW	Right-of-way
RSS	Reserve Station Service
SCR	Selective catalytic reduction
SO2	Sulfur dioxide
SPCCP	Spill Prevention Control and Countermeasure Plan
SQG	Small quantity generator
SRP	Salt River Project Agricultural Improvement and Power District
SSR	Sub-Synchronous Resonance
STS	Southern Transmission System
TWG	Technical Working Group

TEP	Tucson Electric Power Company
WTS	Western Transmission System
WWTP	Wastewater treatment plant
ZLD	Zero Liquid Discharge

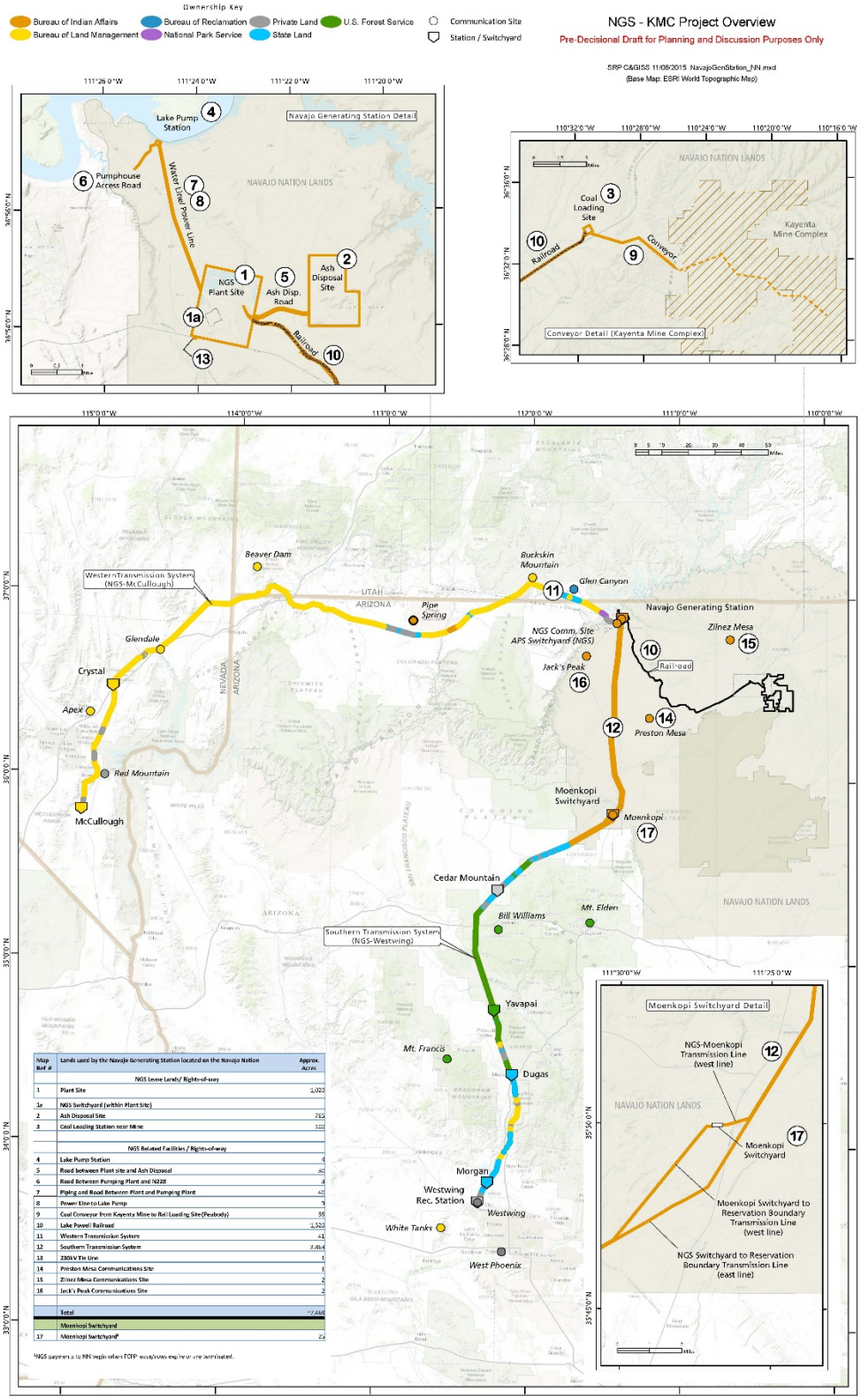
NAVAJO PROJECT

Operation and Maintenance Plan

The Navajo Generating Station (NGS) is located in northern Arizona about 5 miles east of the city of Page on approximately 1,020 acres of land leased from the Navajo Nation (**Figure 1**). Construction of the facility began in 1969 and power production started in 1974. The Salt River Project Agricultural Improvement and Power District (SRP) is the operating agent of NGS and holds a 42.9% ownership interest in NGS on its own behalf. SRP also holds a 24.3% ownership interest in NGS for the use and benefit of the United States of America. NGS's other owners are Arizona Public Service Company ("APS," 14.0%), Nevada Power Company ("NVE," 11.3%), and Tucson Electric Power Company ("TEP," 7.5%). These owners, SRP, and the United States are collectively referred to as the "NGS Participants." NGS currently serves electric customers in Arizona, Nevada, and California, and supplies more than 90% of the power to pump water for Reclamation's Central Arizona Project. NGS has approximately 520 full-time employees.

The NGS plant includes three 750-megawatt (MW) electric generating units that produce up to 2,250 MW of net output. The fuel supply for these units is low sulfur bituminous coal transported by electric train from Peabody Western Coal Company's (PWCC) Kayenta Mine (KM) located about 78 miles southeast of NGS (**Figure 2**). Power is transmitted from NGS via two 500-kilovolt (kV) transmission line systems to substations near Las Vegas, Nevada and Phoenix, Arizona (**Figure 1**). Infrastructure associated with the NGS Project includes a 78 mile railroad and coal handling facilities at the railroad terminus and at the plant; a water supply system from Lake Powell; coal-fired boilers; steam turbine generators; water treatment; air pollution control systems; waste management facilities; transformers, switchyards, transmission lines, and substations; roads; communication sites; administration, operation, maintenance and warehouse facilities. An overview of the NGS facilities is shown in **Figure 3**. **Appendix A** lists the acreages for the components of the Navajo Project facilities on the Navajo Reservation. Descriptions of the individual components of the Navajo Project operations are discussed in the following sections.

Figure 1 - NGS, Transmission System, Railroad, and Kayenta Mine Overview.



Map Ref #	Lands used by the Navajo Generating Station located on the Navajo Nation	Approx. Acres
	NGS Lease Lands/ Rights-of-way	
1	Plant Site	1,003
1a	NGS Switchyard (within Plant Site)	
2	Ash Disposal Site	765
3	Coal Loading Station near Mine	101
	NGS Related Facilities / Rights-of-way	
4	Lake Pump Station	4
5	Road between Plant site and Ash Disposal	80
6	Road Between Pumping Plant and N20E	4
7	Piping and Road Between Plant and Pumping Plant	40
8	Power Line to Lake Pump	4
9	Coal Conveyor from Kayenta Mine to Rail Loading Site(Peabody)	55
10	Lake Powell Railroad	1,520
11	Western Transmission System	41
12	Southern Transmission System	7,814
13	230kV Tie Line	1
14	Preston Mesa Communications Site	1
15	Zilnez Mesa Communications Site	2
16	Jack's Peak Communications Site	2
	Total	7,668
	Moenkopi Switchyard	
17	Moenkopi Switchyard[1]	23

[1]NGS payment is to NN begin when FCPP ceases operation or are terminated.

Figure 2 - NGS Plant Site, Railroad, and Kayenta Mine Complex.

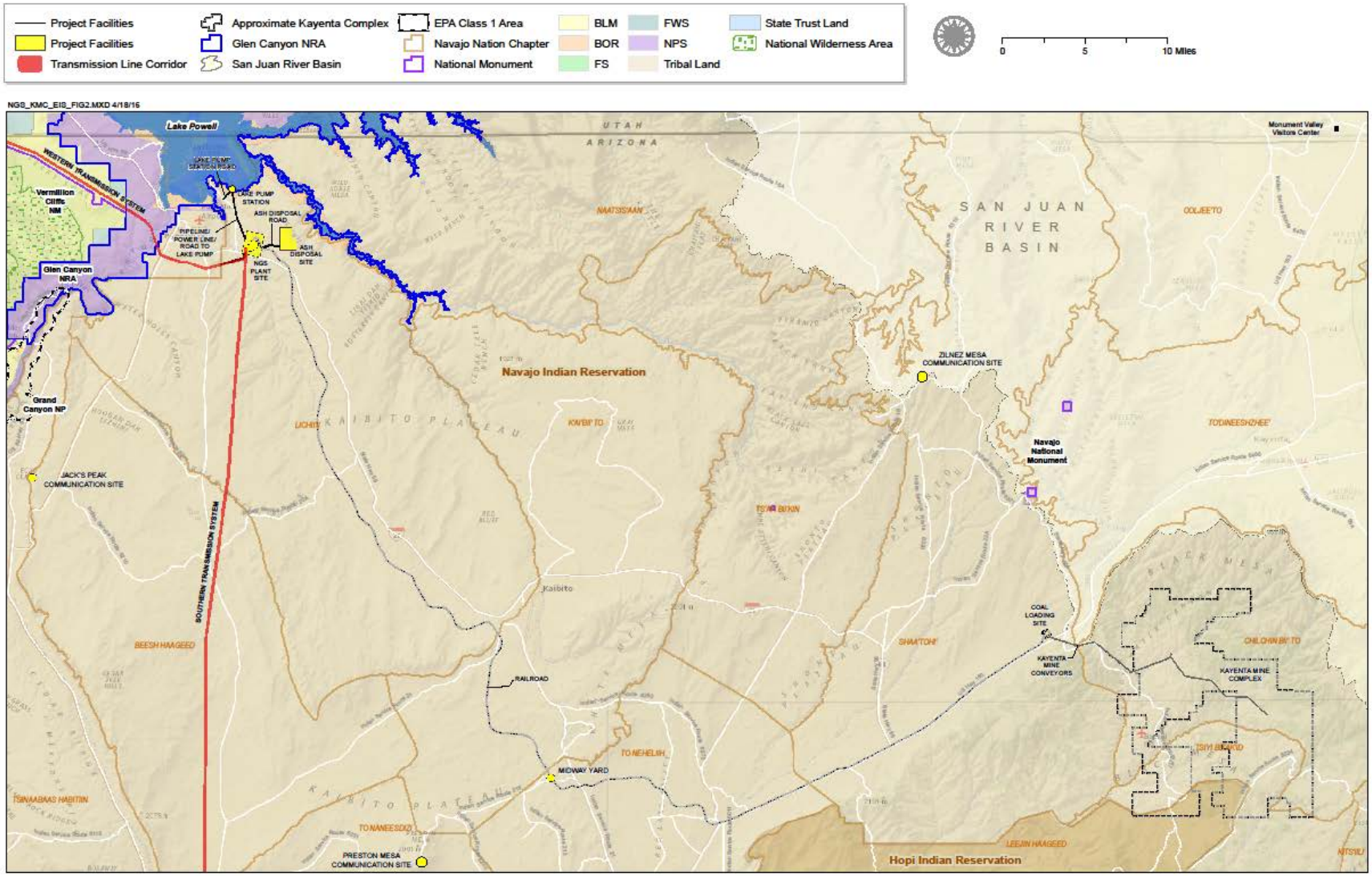
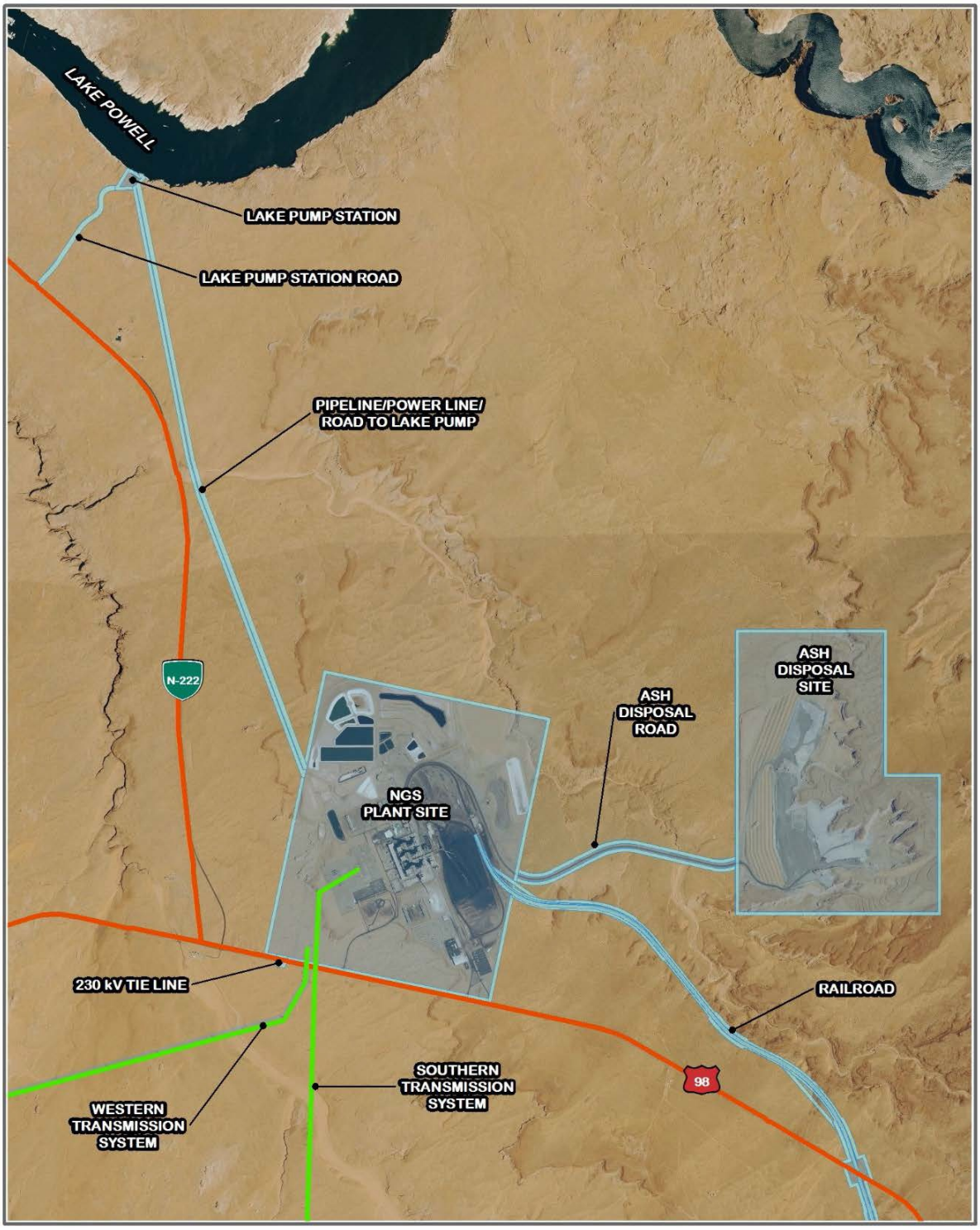


Figure 3 - Overview of NGS Facilities.



The Navajo Project is anticipated to continue operations and power production until closure on December 22, 2019. Retirement of NGS following closure will involve a complex process of decommissioning, dismantling, reclamation, and restoration activities to remove facilities and restore the land. The plans, procedures, and specification for retirement are described in the Retirement Guidelines that are an Exhibit to the Extension Lease. The transmission line systems are expected to remain in operation following plant closure for delivery of power from other energy sources.

NGS PLANT OPERATIONS

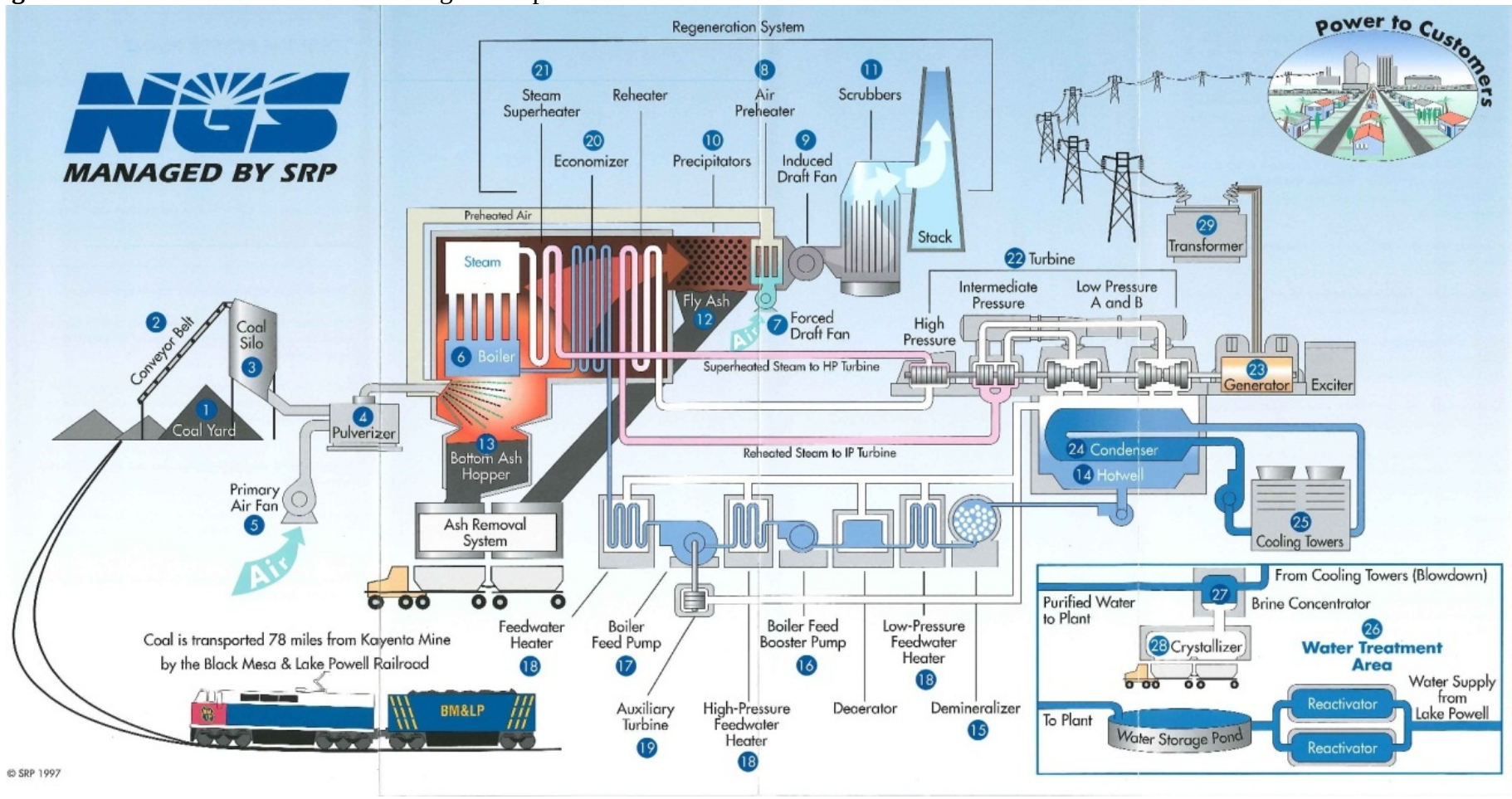
The NGS plant site consists of three pulverized coal-fired steam electric generating units designed to produce up to 2,250 MW net output. In addition to the power units, the plant includes a 78 mile railroad and coal handling facilities at the railroad terminus and the plant; a water supply system from Lake Powell; air pollution control systems; waste management facilities; transformers, switchyards, and substations; roads; communication sites; and administration, operations, maintenance and warehouse facilities (**Figure 4**). The 500-kV switchyard is used for transmission of the plant electrical output to NGS Participants and is controlled and operated by APS. The 230-kV switchyard is connected via a tie line (ROW shown in **Figure 3**) to a 230-kV transmission line between Glen Canyon Dam and Kayenta that is owned and operated by others. The 230-kV facilities can provide backup power for plant startup as needed . This switchyard provides a reserve station service supply and 50-kV power for the railroad catenary. The overhead catenary system provides the electrical supply for operation of the coal train. The entire water supply for plant operations is pumped about 4 miles from Lake Powell.

Current Operations

Pulverized coal is delivered to the furnace of each of the three electric generating units (**Figure 5**). The boilers for the three power units operate at 3,600 pounds per square inch (psi) steam pressure and 1,005°F steam temperature, with forced circulation, divided furnace, balanced draft air flow, and seven levels of tangentially fired low-nitrogen oxide (NOx) coal burners (56 per unit). Flue-gas for each unit passes through an electrostatic precipitator and sulfur dioxide (SO_2) scrubber before it exits through a 775-foot-high steel-lined concrete stack.

Figure 4 - NGS Plant Layout.

Figure 5 - Overview of Electric Generating Unit Operation.



NGS turbines are General Electric tandem compound four-flow exhaust machines with a gross output of 810 MW per unit. Each turbine-generator set is arranged with the turbine shaft perpendicular to the boiler centerline and the single-shell main condenser is longitudinally mounted underneath the low-pressure turbine exhausts. Horizontal feedwater heaters are located at the mezzanine and operating deck levels using extraction steam to preheat boiler feedwater. Steam discharged from the turbines circulates through cooling tubes of the condenser where it condenses. The heat from the circulating water is removed by evaporation in six cooling towers – two for each unit. Historically the units required periodic shutdown (either planned or unplanned) to complete repairs, preventative maintenance, improvements and regulatory compliance activities. Although ongoing maintenance and repairs to the units will continue, no scheduled outages are anticipated through 2019.

The plant is continually maintained during ongoing operation. Many systems have redundant components that can be individually shutdown to conduct maintenance, preventative maintenance, repairs, improvements, and to perform regulatory compliance activities. Some components in various systems can be worked on to conduct these same activities while the component continues in service. During operation, the various systems are subject to testing and control changes so that they can safely and reliably respond to owner requests for energy from NGS. The various systems that make up a unit have safety systems and components in place that in the event of a component failure, the system will automatically respond to protect against further damage to components or compromise the safety of employees and other people at the plant.

Gross NGS annual energy output from 2009 to 2016 ranged from 13.1 to 18.6 million megawatt hours (MWh), with net annual output ranging from 12.0 to 17.2 million MWh. Generation capacity is distributed proportionally to the NGS Participants according to their Generation Entitlement Share. During operation, NGS Participants may occasionally curtail a percentage of their share of generation in response to market conditions. Electricity used for on-site operations includes about 110,000 MWh/yr for auxiliary power to the units. All on-site electrical power is supplied by output from the three NGS units except about 200 MWh/yr from the 230-kV switchyard, which comes from hydropower generated at Glen Canyon Dam or from Kayenta and is used for emergency back-up power to the units and the lake pump station.

Electricity for operation of the railroad to KM is purchased from the Navajo Tribal Utility Authority (NTUA) and is delivered to the 230-kV Switchyard. NGS energy purchases for railroad operation averaged 1,937 MWh per month from August 2010 to July 2013. Monthly energy purchases for this period ranged from 1,417 MWh to 2,275 MWh (Brightwell, pers. comm. 2013).

FUEL SOURCE, SYSTEM, AND HANDLING

The following is a description of the coal source from the KM, transport of coal from the mine to NGS, coal handling at NGS, and other on-site fuel storage and uses at NGS. Additional information on the KM mining operations and reclamation is available from PWCC.

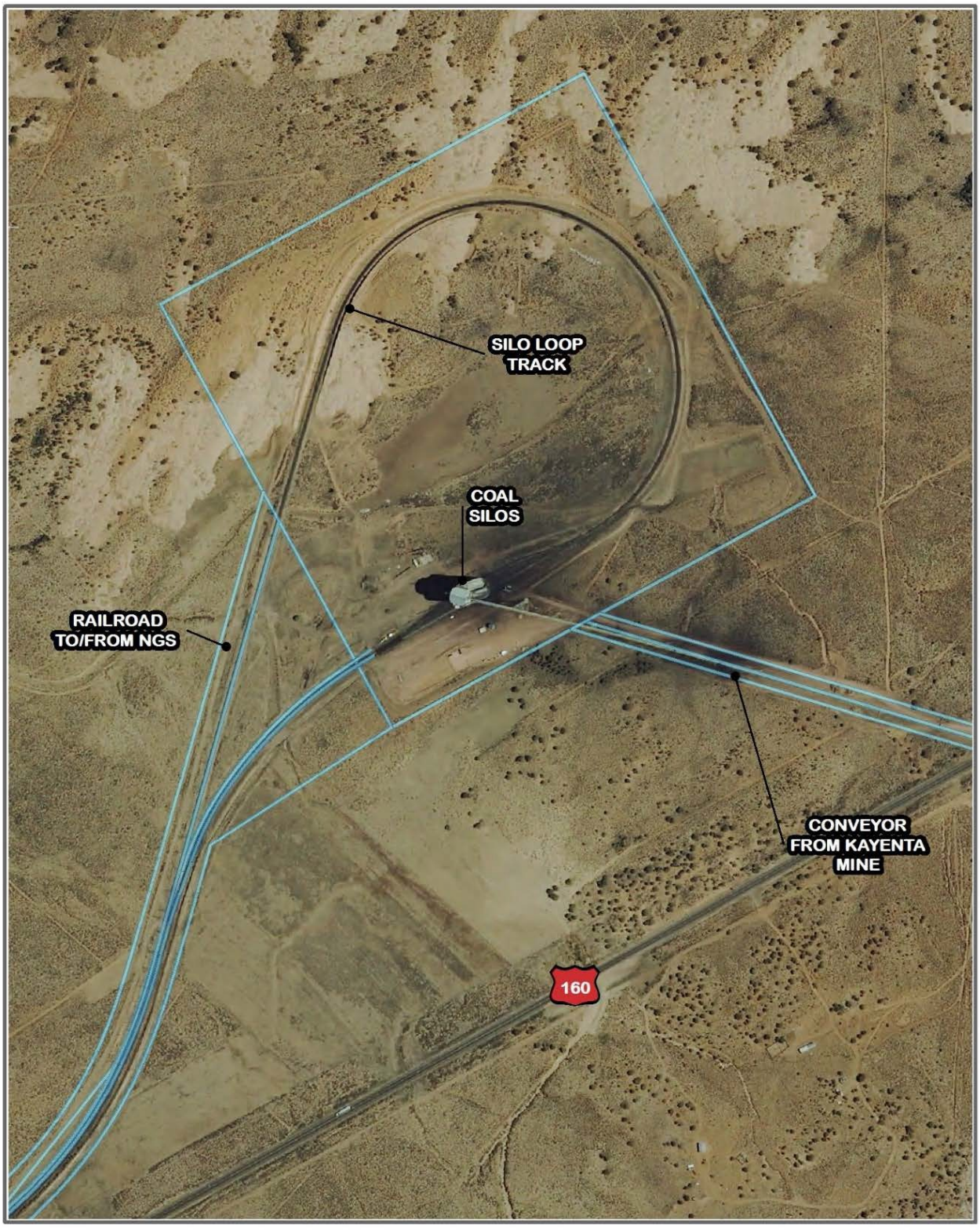
Coal Source — Kayenta Mine

The KM supplies all of the fuel for operation of NGS via the Black Mesa and Lake Powell Railroad (BM&LP Railroad). The mine is about 78 miles southeast of NGS (**Figure 2**). NGS participants have a coal supply agreement with PWCC with a term ending December 2019. PWCC holds coal mining leases with the Hopi and Navajo Nation to produce up to 290 million tons from the Navajo Lease Areas and up to 380 million tons from the Hopi and Navajo 222 Joint Minerals Ownership Lease Area. All of the current and future coal resource areas are assigned to the NGS Participants. PWCC operates and maintains the KM and overland conveyor[1] that transports coal to the railroad coal loading site[2]. KM would continue to provide coal to NGS until NGS operations cease.

The four storage silos at the coal loading site are constructed of steel-reinforced concrete and are tied together into a single structure (**Figure 6**). Trains are loaded out of two of the four silos at a time for transport to NGS. Typically, an 8,000-ton train (e.g., 80 cars at 100 tons/car) can be loaded in about 40 minutes. The BM&LP Railroad and associated facilities (e.g., Midway Station, catenary) are operated, maintained, improved, modified and moved within the ROW as needed by SRP (see description below).

[1] The conveyor used at the KM to transport coal is referenced as the "Coal Conveyor from Mine to Loading Station" in the Lease between SRP and the Navajo Nation
[2] The coal loading site is referenced as the "Coal Loading Station near the Mine" in the Lease between SRP and the Navajo Nation

Figure 6 - Coal Loading Site.



Black Mesa & Lake Powell Railroad Coal Delivery

Current and Planned Operations through 2019

The Black Mesa & Lake Powell railroad (BM&LP Railroad) (**Figure 7**) is used to deliver coal from KM to NGS (**Figures 1** and **2**). The track extends 78 miles northwest across the Navajo Reservation from the coal loading site at Black Mesa on the north side of Highway 160 to NGS. Including the railroad loops at each end, the total length of the system is about 80.4 miles. As the BM&LP Railroad is a private railroad and a closed system that does not connect with any other railroads, it is not under the jurisdiction of the Federal Railroad Administration (FRA). When NGS is running at full capacity, the train runs 24 hours a day 7 days a week and completes three round-trips per day, delivering approximately 8,000 tons of coal per trip. A round trip normally takes 6 to 7 hours.

Figure 7 - Coal Delivery Train.

BM&LP Railroad currently uses bottom dump hopper cars manufactured by Freight Car America, Trinity, Ortner, and Gunderson. The cars are loaded from silos using an overhead loadout chute system in a completely concreted area. Each car is loaded with a maximum of 100 tons of coal. The cars are filled to a level below the top to minimize spillage and exposure to the

wind during transport. Any observed spillage during the loading process is cleaned up after the train leaves the coal silo load out area.

Ongoing operation, repair, preventative maintenance and improvements of the railroad track structure, catenary system, all crossing locations, crossing gates, signals, signage, right-of-way (ROW) roads, fences, water drainage systems, culverts, and cattle guards is performed to ensure the safety of train operations, the safety of the public, and prevent livestock from accessing the right-of-way[3] As part of the service program, each train receives a periodic exterior inspection. When maintenance activities are performed, emphasis is placed on the braking system and the integrity of the cars.

Railway operations teams are trained to use standardized visual and auditory signals for public safety communication. For example, train operators will sound a continuous whistle when an object of concern is observed on the track. The locomotive horn, bells, and ditch lights that flash on and off are used at crossings. Headlights are used to increase train visibility whenever a train is in motion. Flares are used at crossings during the night to provide warning to keep people from driving into the crossing when crossings are obstructed by stationary cars. Train operation is limited to a maximum of 50 miles per hour (MPH) using the train electronic speedometer and by the operators checking their speed by using the mileposts. Trains are required to slow during vision-impairing weather conditions to a speed that ensures safety, and stop when tracks are flooded. Bells and whistles must be sounded frequently under these conditions. Troubleshooters and repair personnel are dispatched to restore function as soon as possible when a concern is identified. To protect operators and the public when railroad crossing signals and gates are taken out of service for repair, a “stop and proceed” order is given to train operator crews and the crossings are flagged by NGS personnel until the crossing can be returned to normal service. When a report of right-of-way fence being removed or damaged is received, a crew is dispatched to repair the fence to prevent livestock from entering the right-of-way.

[3] The BM&LP Railroad was designed to minimize the disruption and impediment of livestock movement to accommodate the Navajo Nation’s open-range grazing uses. The railroad ROW is completely fenced to keep livestock away from the rail except at the open crossings. Livestock owners with a grazing permit along the ROW can file claims for losses due to incidents with the train through SRP’s Litigation and Claims Department. BM&LP Railroad train operators make reports of livestock-related accidents when they occur. Claimants must also provide a Statement of Loss Livestock Incident form, an IRS W-9 form, and a Livestock Report to help determine the value of the livestock involved in the accident.

Public safety warning devices at 36 low-use public crossings include a Railroad Cross Buck warning sign and STOP signs (**Figure 8**). The four crossings located at mile posts 31, 42, 55, and 66 have electronic warning lights and bells as additional safety warnings to the public (**Figure 9**). In addition to the other safety features, crossing arms are installed at mile post 66 where State Highway Route 98 crosses the rail line (**Figure 10**). When an incident involves the train and a motor vehicle, the Navajo Nation police are notified by SRP to investigate the incident. There have been approximately 10 to 15 incidents involving the train and motor vehicles, including three incidents in the past 15 years.[4]

Figure 8 - Mile Post 36 Low-Use Road Crossing.

[4] The BM&LP has never been deemed responsible for any railroad crossing incident involving a motor vehicle.

Figure 9 - Railroad Crossing at Mile Post 58. (Typical of Mile Posts 31, 42, 55, 66).

Figure 10 - Railroad Crossing at Mile Post 66, where State Highway Route 98 Crosses Tracks.

The Midway Station located at mile post 42 (**Figure 11**) may be used as a crew assembly location, a pullout siding for railroad cars and locomotives, a maintenance facility, and a warehouse to store rails, track switch components, cross ties, other track hardware and supplies,

and small quantities of chemicals used for maintenance purposes (e.g., WD-40, 10W hydraulic oil).

Figure 11 - Midway Station.

The BM&LP Railroad is powered by a 50-kV overhead catenary system with energy purchased from the NTUA under an electric service agreement between NTUA and SRP on behalf of the NGS Participants. Power for railroad operation is delivered at the NGS 230-kV switchyard. NGS is responsible for operating, maintaining and improving all facilities required for the transformation and transmission of the electric power and energy for railroad operation from the NGS 230-kV switchyard to the train.

The existing railroad would be operated and maintained as appropriate throughout NGS operations on a continuous basis. Rock ballast underneath the rail and ties and railroad ties would be replaced as needed.. To minimize waste and allow use of equipment that is compatible with the catenary height, at times new ballast is added to the existing ballast as needed rather than removing old ballast. In some locations, old ballast may be removed. Catenary components and hardware would also be replaced on an as-needed basis. No railroad maintenance activities or land disturbance is expected to go beyond the footprint of the railroad ROW.

Coal Handling and Storage at the Navajo Generating Station

Current and Planned Operations through 2019

Low sulfur bituminous coal from KM is the primary fuel for the three units at NGS. Approximately 8.2 million tons of coal per year are used at NGS for power generation. The coal yard is located on the north side of NGS (**Figure 12**). As previously described, the coal is delivered to NGS by the railroad via a 50-kV electric train with 100-ton-capacity bottom-dump hopper cars. The coal is crushed to a 2-inch size at the mine for ease of handling and transport. At full load, the three power plant units burn coal at a rate of approximately 1,000 tons per hour. Ongoing maintenance keeps the coal handling system efficient, safe, and able to control combustible coal dust particulates.

Figure 12 - NGS Coal Yard.

Once a full train arrives at the plant site, it slowly travels through the track hopper building (**Figure 13**) where the coal is dumped from the bottom-dump hopper cars at a manually controlled speed into 12 underground enclosed hoppers. Each hopper's capacity is 1,050 tons, giving the track hopper a total capacity of 12,600 tons.

Figure 13 - Coal Handling Facilities at NGS.

All 12 hopper feeders discharge coal onto a horizontal conveyor belt running underneath the track hoppers. The coal is then transported by a series of belt conveyors to the coal sampling station which removes a small continuous coal sample from the main coal stream for testing of sulfur content, moisture, ash, and BTUs per pound of coal. The coal is then transported to the yard bin and then to the plant bin where it is distributed to each unit's silos.

The yard bin has two outlet hoppers and each hopper has a variable-speed vibratory type feeder and a fixed-speed vibrating coal scalping screen that removes tramp iron and rocks from the coal stream. The coal discharged from the yard bin is transported to the plant by two parallel inclined belt conveyors.

Any excess coal over that needed to maintain plant burn rate is transported to the active 3-day storage pile from the yard bin. The coal is reclaimed from the active 3-day storage pile by the bucket-wheel stacker/reclaimer whenever coal coming from the track hopper is insufficient to maintain the plant burn rate. The coal reclaimed by the stacker/reclaimer is transported by conveyors to the yard bin.

When coal is not available from the active storage pile or train, then it is reclaimed from the dead storage pile by diesel powered belly scrapers, assisted by bulldozers, and discharged into the underground emergency reclaim hopper. The emergency reclaim hopper consists of two outlet hoppers, each equipped with variable-speed vibratory feeders. Both feeders discharge coal to an inclined belt conveyor, which discharges above ground into a fixed-speed vibrating coal scalping screen that removes tramp iron and rocks from the coal stream. The coal is then discharged onto a long horizontal belt conveyor, which discharges to either of the two conveyors leading to the plant bin.

The dead storage pile contains approximately 30 days of coal supply and is compacted and watered to control coal dust emissions. The coal discharged from the yard bin or emergency reclaim belt conveyor is transported to the plant bin by conveyors located between Units 2 and 3. The plant bin is divided into two halves and the coal is diverted to either half by a manually controlled pneumatically-actuated diversion gate. Each half of the plant bin has two outlet hoppers, one for Units 1 and 2 and the other for Unit 3. These outlet hoppers divert the coal to the cascade system which delivers the coal to the seven silos at each unit.

There are seven coal silos per unit – one for each coal pulverizer (bowl mill). Each silo outlet has a variable speed gravimetric belt feeder that controls the amount of coal going into each running pulverizer. These seven, 135,000-lb per hour capacity, bowl mills pulverize the coal, and tilting tangential low NOx burners located near the corners of the furnace admit the coal and air required for combustion into the furnace. Each mill supplies a single elevation of burners. By distributing the fuel in this fashion, a balanced fire is maintained regardless of which mills are in or out of service.

Coal Handling – Dust Suppression Systems

Dust emissions in the coal handling system are controlled using enclosures, dust-suppression sprays, and dust extractors. The dust-suppression system is divided in two subsystems – train unloading dust suppression and coal conveyor dust suppression. The train unloading dust suppression misting system is used when dumping coal from the rail cars into the track hopper. All conveyors, except one reclaim conveyor, are housed in conveyor galleries. Aboveground components of the coal conveyor system are mostly enclosed. Dust extractors and openings ensure ventilation in the coal conveyor galleries for worker ventilation and to reduce the risk of coal dust explosions.

Ongoing operation, maintenance and improvements are performed on all coal handling equipment. Repairing, refurbishing, and replacing worn coal handling equipment would continue as necessary to maintain proper operation. Changes will be made as needed to improve safety, efficiency, dust control, environmental control, and other necessary improvements.

Fuel Oil for Boiler

Current and Planned Operations through 2019

NGS uses D2 diesel fuel oil for its main boiler igniters, warm-up oil guns, and as the main fuel source for its auxiliary boilers. Fuel is delivered to NGS by tanker truck according to demand. Diesel fuel oil is typically delivered from multiple sources in New Mexico and Arizona but can come from anywhere.

The on-site fuel oil system is composed of a 120,000-barrel bulk fuel oil storage tank (**Figure 14**), a day tank, three fuel oil burner supply pumps, one fuel oil recirculation pump, two fuel oil transfer pumps, and an array of piping that allows for multiple configurations to pipe oil from

either the bulk or day tank to the power plant where it is used in either the main boilers or the auxiliary boilers.

A site specific Spill Prevention Control and Countermeasure Plan (SPCC) describes measures to prevent fuel oil discharges and mitigate the impact of any discharge to navigable waters of the United States. A tank inspection program, earthen berms and other structures are key provisions of this plan.

Figure 14 - Primary Fuel Oil Storage Tank.

The on-site fuel oil system is a recirculation system where oil is pumped as needed from either the day tank or the bulk tank by the burner supply pumps to the power plant, maintaining a set pressure. The oil that is not used at the power plant recirculates back to the day tank or bulk tank to be reused in the system. The recirculation pump is used during low-flow conditions. The fuel oil transfer pumps are used to transfer fuel from incoming supply trucks to either the bulk storage tank or the day tank. Ongoing activities include operation, maintenance and improvements of equipment and systems.

NGS Vehicle Fuel Use

Current and Planned Operations through 2019

Diesel and gasoline fuels are used in vehicles at NGS plant for a variety of purposes.

Headwaters Inc. operates vehicles and equipment for use in dust suppression, fly ash hauling, and other operations. Typical annual fuel use and/or mileage for the different vehicles and equipment used are shown in **Table 1**.

NGS maintains aboveground diesel and gasoline tanks and the fuels are piped to a fuel island near the heavy equipment shop. The fuel island has a kiosk that authorizes dispensing fuel from two pumps and requires the operator to enter the vehicle and mileage or equipment number. NGS also has two diesel tanks in the railroad loop area; these tanks dispense fuel and have a meter to track the gallons. Fuel from the two diesel tanks are dispensed into the railroad loop locomotive as well as the NGS lube service truck that provides fuel to NGS equipment at various locations.

Headwaters Inc. does not maintain any fuel tanks or dispensing system at NGS. Instead, they use a fuel vendor that comes in from off-site and refuels their equipment and service truck. The Headwaters Inc. service truck has a dispensing fuel tank that can supply fuel to the equipment needed before the fuel vendor returns on a schedule.

Table 1 - Vehicle Fuel Use at NGS (2015).

Vehicle/Equipment	Number of Vehicles	Fuel	Annual Hours of Operation	Gallons per Hour	Annual Mileage	Annual Fuel Consumption (gallons)
Cars/SUVs	13	Unleaded			47,326	4,752
Trucks (under 1 ton)	45	Unleaded			324,691	32,188
Trucks (over 1 ton)	3	Unleaded			1,053	566
Trucks (under 1 ton)	2	Diesel			2,099	3,537
Trucks (over 1 ton)	13	Diesel			84,698	15,747
Semi-tractor/trailer	2	Diesel			4,383	1,153
Cranes	5	Diesel	849			828
Cranes (over 1 ton)	5	Diesel	2,142			1,324
Forklift (over 1 ton)	5	Diesel	1,599			1,531
Forklift/Manlift	14	Diesel	3,361			3,500
Welder/compressor	17	Diesel	1,626			2,487
Generator	8	Diesel	496			435
Dozer/Grader/Scraper	8	Diesel	9,972			51,376
Loader	6	Diesel	2,765			4,595
Locomotive	1	Diesel	1,000			6,000
Other	1	Diesel	81			113
Headwaters (Contractor)						
Service/Fuel Truck	1	Diesel	520	0.9	6,570	468
Ash trucks	4	Diesel	7,072	11.7	61,320	82,742
Dozer/Grader/Scraper	3	Diesel	676	4.5	3,285	3,042
Loader	3	Diesel	2,392	4.5	2,190	10,764
12,000-gallon water truck	1	Diesel	2,912	9.4	22,995	27,373
12-yard Crystallizer truck	3	Diesel	78	0.9	1,095	70
El 300 Excavator	1	Diesel	16	0.9	51	14

Source: SRP mileage reports and Headwaters records.

Major Chemical and Product Deliveries to NGS

Current and Planned Operations through 2019

NGS receives periodic bulk delivery of chemicals, diesel, and other products required for operation of the facility (**Table 2**). Periodic deliveries of these materials, typically by large diesel trucks, are made throughout the year from various sources. Limestone deliveries are the most frequent and are required for operation of the SO_2 scrubber flue-gas desulfurization system used for sulfur dioxide emission control.

Chemicals are needed for various plant processes including but not limited to water treatment, emission controls, equipment protection, process cooling, and dust control. The bulk chemical listing and transportation quantities could change in the future as generation and technology changes.

Table 2 - Major Bulk Chemical and Product Deliveries to NGS.

Product	Truck Deliveries (2014)	Load Size	Point of Origin
Limestone	3,664	25 ton, 37.2 ton or 41 ton trucks	Apex, Nevada
Calcium Bromide for control	230	3,200 gallons	Buckeye, AZ
Powder Activated Carbon mercury control	15	2,000	Coushatta, LA
Diesel	175	7,200 gallons	Holbrook, AZ: Phoenix, AZ; Las Vegas, NV; Farmington, NM; American Fork, Utah
Ammonium hydroxide	3	45,000 pounds	Salt Lake, UT
Caustic soda	5	3,600 gallons	Buckeye, AZ
Sulfuric acid	151	3,300 gallons	Haden, AZ
Lime	122	40 tons	Cricket Mountain, UT
Ferric sulfate	27	71,000 pounds	Salt Lake City, UT
Ferric sulfate	2	44,000 pounds	Salt Lake City, UT
Ferric sulfate	1	20,000 pounds	Salt Lake City, UT
Sodium hypochlorite	30	45,000 pounds	Henderson, NV
Hydrogen	11	111,000 cubic feet	Phoenix, AZ
Carbon dioxide	10	9.3 tons	Phoenix, AZ
Nitrogen	2	53,000 cubic feet	Tucson, AZ
Soda Ash	263	24 tons	Argus, CA

Note: Data for 2014 with the exception of calcium bromide and PAC based on 2016 annually adjusted actuals.

WATER USE AND MANAGEMENT IN PLANT OPERATIONS

Water Source and Delivery

Water delivered from Lake Powell is used for a variety of functions at the NGS including but not limited to the boilers, bearing cooling, cooling towers, service water system, fire water

system, and potable water. Water is treated, reused, and recirculated to the maximum extent possible to minimize deliveries from Lake Powell.

Current and Planned Operations through 2019

NGS was constructed near Lake Powell to ensure it had a dependable supply of cooling water for its three electric generating units (**Figure 1**). The lake pump station is located at an elevation of 3,734 feet and is adjacent to the lake shore on a parcel of land leased to NGS by the Navajo Nation (**Figure 15**). The site includes the water intake wells and buildings that house pumps and electrical transformers. The entire make-up water requirement for NGS Units 1, 2, and 3 is obtained from Lake Powell and pumped via two 30-inch supply lines to the generating station. NGS has an annual allocation of 34,100 acre-feet per year for consumptive use and an allocation for 5,900 acre-feet for non-consumptive use for a total allocation of 40,000 acre-feet per year. Over the past 15 years, annual water use has varied from about 16,000 up to 29,000 acre-feet per year.

The original intakes that pump water from the lake to the plant were installed at an elevation of 3,470 feet, or 230 feet below the lake's "full pool" level of 3,700 feet. In 2004, SRP modified the water intake system to maintain access to the Lake Powell water supply to mitigate an unexpected drop in reservoir level due to ongoing drought. Following a National Park Service (NPS) environmental assessment (NPS 2007), construction of the new intakes began in 2007 and was completed in 2009. The new intakes are located approximately 120 feet lower (at elevations from 3,330 to 3,350 feet) than the original intakes, and are in the "dead pool" of Lake Powell (elevation 3,370 feet). This required an expansion of the intake easement during project construction (**Figure 15**). The dead pool is the lowest elevation the water level in the reservoir can drop based on the elevation of the dam's outlet works.

Five submersible first stage pumps lift the lake water to five second-stage booster pumps via independent pipelines. The five corresponding second-stage booster pumps are horizontal and discharge the raw lake water at rates equal to the three-unit plant maximum make-up flow requirement of 28,000 gallons per minute into a discharge manifold. The discharge manifold is connected to two 30-inch concrete cylinder supply lines. The supply lines discharge at the power plant site into two 11-foot-diameter 27-foot-high influent tanks that feed the respective station make-up water clarifiers.

Figure 15 - NGS Lake Powell Water Intake at the Lake Pump Station and Pipeline.

The concrete cylinder pipelines for transporting the water to NGS, and the power lines from the plant's switchyard to the lake pump station for powering the pumps, are located within a 2.85-mile-long ROW. The pipelines are buried from 5 to 20 feet deep. The power lines, along with communications and control cables (fiber optic cables), are suspended from single wooden poles ranging from approximately 40 feet to 55 feet tall. Cathodic protection wells and monitors are also located within the ROW.

Normal access to the lake pump station for operations and maintenance personnel is from Arizona State Highway Route 98 to Navajo Nation Route 222, then by Navajo Nation Route 22-B, the unpaved lake pump station road (**Figure 15**).

Historically, annual consumptive water use has ranged up to about 29,000 AFA, but with lower energy production in recent years, annual water use dropped to about 16,000 AFA in 2016. Water use through 2019 is expected to range from about 16,000 to 22,000 AFA but could be up to 29,000 AFA if maximum generation occurs.

Water Treatment

Current and Planned Operations through 2019

All of NGS water needs for power plant operations are met by water pumped from Lake Powell. Lake Powell water is naturally high in hardness. Use of raw hard water in NGS's water systems would plug the many tubes and pipes and require substantial cleaning and maintenance. To minimize the maintenance and risks to the systems associated with using raw lake water, NGS uses a water treatment facility to remove hardness and adjust pH prior to use in the power plant systems.

Water from Lake Powell is delivered into two cold-process lime and soda ash softener tanks at the water treatment facility. Slaked lime and hydrated soda ash are added to the softener tanks to create the chemical process to remove hardness from the water. Other chemicals such as polymers and ferric sulfate are also added to improve the effectiveness of the chemical reactions in the softener. After the water is treated in the softener tanks, it flows to make-up reservoirs.

Between the softeners and the make-up reservoirs, the water is treated with sulfuric acid for pH control and sodium hypochlorite to prevent biological growth in the water. The water

stays in the make-up reservoirs until it is distributed to various water systems that use softened water. Those systems include the circulating water system, service water system, potable water, boiler water, and fire water system.

Operation, maintenance, replacements, and improvement activities are ongoing and would continue in the future. No expansion of the water treatment facilities beyond the existing footprint is planned. The volume of water requiring treatment will vary with power generation.

Water Use

Current and Planned Operations through 2019 - Cooling Towers and Circulating Water System

The cooling towers at NGS are part of the circulating water system that provides cooling water to the main turbine condensers and bearing cooling water systems. NGS has six cooling towers, two per unit. Each cooling tower is about 400 feet long (**Figure 16**). Water requirements for the system are provided by two pumps per unit (one for each cooling tower), which draw water out of a basin at the bottom of the cooling towers and then pumps the water to the main condenser. At the main condenser, the circulating water goes through metal tubes where it absorbs heat from the steam exiting the unit's turbine. As the turbine steam is cooled and condenses, the water falls to the bottom of the main condenser. The heated circulating water then returns to the cooling towers to be cooled by evaporation and then pumped back to the main condenser.

Between the circulating water pumps and the main condenser, two lines branch off to supply water to the bearing cooling water heat exchangers. The circulating water absorbs heat from the bearing cooling water systems and then returns to the cooling towers.

Plant cooling water circulates repeatedly, and much of it is lost through evaporation at the cooling towers. This leads to an increase in the solids concentrations in the cooling water system. To keep the solids concentration within acceptable limits, a cooling tower blowdown system sends circulating water with high dissolved solids to holding basins where it is treated and recycled. The concentration of dissolved solids in the circulating water system is constantly measured by conductivity sensors. The blowdown process is initiated when conductivity reaches a maximum level. Additional water is then added from the make-up reservoirs to the

circulating water system to keep solids at a desired level (**Figure 16**). Make-up reservoirs are filled by gravity flow from water softeners near the cooling towers. The make-up reservoirs serve all six cooling towers.

Figure 16 - Make-up Reservoirs Near Cooling Towers.

Ongoing operation, maintenance, replacement and improvement is anticipated for the cooling towers. The cooling tower fans are periodically balanced. Structural supports, fill, and other components are inspected, replaced and improved as necessary during outages. Circulating water pumps and motors receive routine maintenance and are sometimes replaced. No maintenance, repair, or improvement to the cooling towers or circulating water system is anticipated that would go beyond the existing footprint.

Current and Planned Operations through 2019 - Potable Water

Raw water for use at the NGS facility is supplied by the lake pump station and pipeline from Lake Powell. Water is treated on-site at a water treatment plant and delivered via pipelines throughout the facility for drinking water and other potable uses. The facility is in compliance with requirements under Safe Drinking Water Act regulations as noted in **Table 12**.

AIR POLLUTION CONTROL SYSTEMS

Several stages of air pollution controls are used to remove particulate matter, sulfur dioxide (SO_2), NOx, mercury and air toxins resulting from coal combustion as described below.

- Particulate matter (i.e., fly ash)- Particulate matter is removed from the flue-gas by hot-side electrostatic precipitators and SO_2 scrubbers.
- SO_2- SO_2 is removed by forced oxidation in the wet SO_2 scrubbers.
- Nox- NO_x emissions are primarily controlled in the combustion process by the use of low NOx burners and separated overfire air (SOFA).
- Mercury emissions are controlled by using calcium bromide (CaBr2) in the boiler to oxidize the mercury and the FGD absorbers to remove the mercury assisted by the injection of powdered activated carbon into the absorber slurry.

Fly Ash Removal with Hot-side Electrostatic Precipitators

Current and Planned Operations through 2019

The NGS hot-side electrostatic precipitators are designed to remove 99.5% of fly ash from the flue-gas before it is discharged from the stack (**Figure 17**). Electrodes within the precipitators are given a negative electrical charge and adjacent plates (curtains) are positively charged. The flue-gas is forced through the precipitators where the negatively charged fly ash is attracted to the opposite charged curtains. Rappers above the curtains are used to knock the fly ash captured by the curtain into the hoppers below. The precipitators are classified as “hot-side” because they are placed before the air preheaters in the flue-gas flow path. Ongoing operation and maintenance are anticipated for the precipitators.

Figure 17 - Hot-side Electrostatic Precipitators (Upper and Lower Decks).

Sulfur Dioxide Emissions Control with SO_2 Scrubber

Current and Planned Operations through 2019

NGS installed SO_2 scrubbers – also known as flue gas desulfurization (FGD) systems -- on all three units between 1997 and 1999 (**Figure 18**). These scrubbers remove at least 90% of SO_2 from plant flue gas. The system uses a limestone slurry mix to chemically remove the SO_2. The slurry is sprayed downward into an absorber vessel in which the flue-gas also passes (**Figure 19**).

Figure 18 - SO_2 Scrubbers.

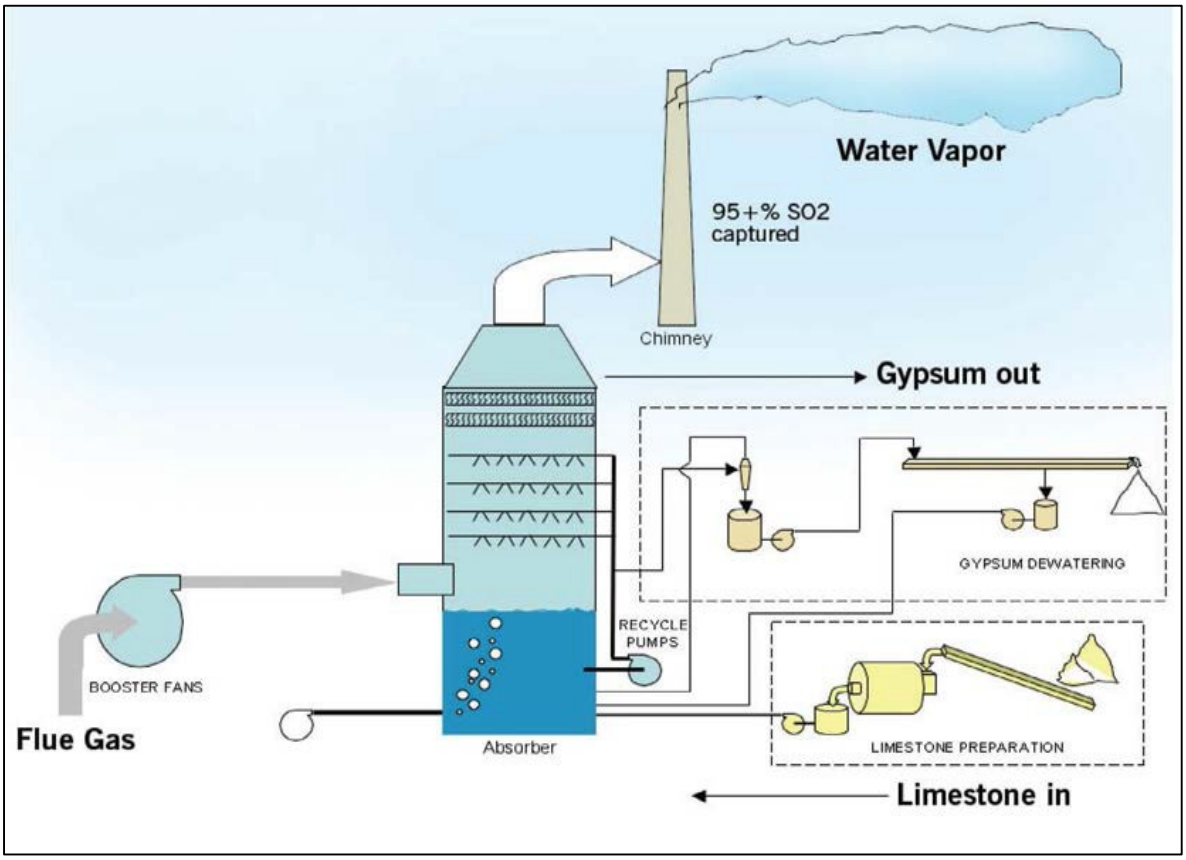


Figure 19 - Absorber Vessel.

The flue-gas is forced through the limestone slurry spray allowing a chemical reaction to take place that absorbs SO_2 into the slurry. The SO_2-rich slurry then has oxygen added to it to turn it into a neutral substance (calcium sulfate or gypsum). Next, the gypsum is dewatered leaving a solid substance that is disposed of at the on-site ash disposal site and the filtrate solution is returned to the limestone slurry process. Each scrubber system is equipped with a spare pump to ensure continuous availability of the pollution controls.

NGS uses on-site limestone storage and processing facilities that use raw limestone to create slurry for use in the SO_2 scrubber vessels. These facilities consist of the limestone handling building and the limestone preparation building.

Semi-trucks deliver raw limestone to the limestone handling building where it is dumped into underground silos or a 30 day storage pile. The underground silos feed the necessary amount of raw limestone to a conveyer belt, which transports the raw limestone to large silos located in the limestone preparation building. In the limestone preparation building, the silos feed raw limestone to a ball mill where the raw limestone is mixed with water and crushed into a slurry.

The newly produced slurry is then transported to each unit's limestone feed tank as needed and fed into the wet SO_2 scrubbers to effect the SO_2 removal process. Both the limestone handling and limestone preparation buildings have dust collection systems with baghouses to collect fugitive limestone dust.

Ongoing operation and maintenance of the sulfur dioxide emission control equipment will continue.

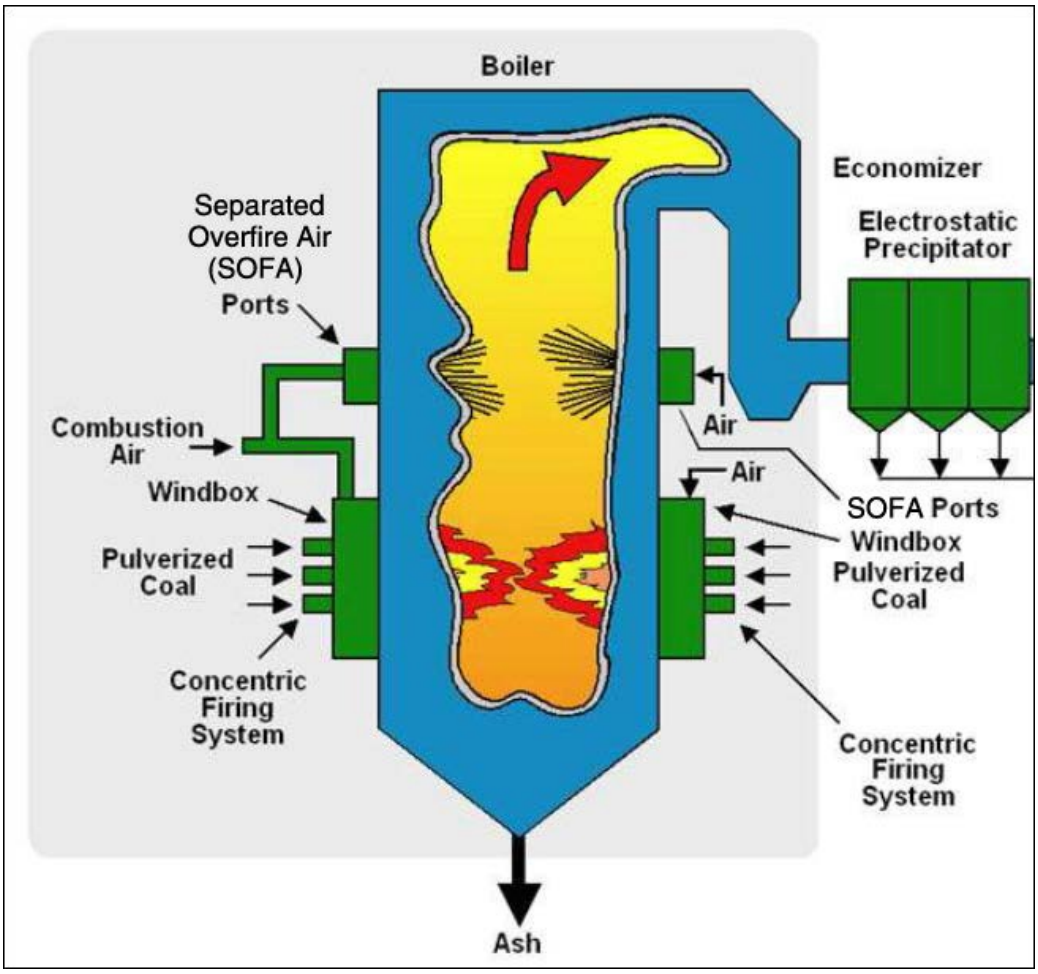
Nitrogen Oxide Emissions Control with Low NOx Burners

Current and Planned Operations through 2019

NGS voluntarily installed low NOx burners with SOFA on all three units between 2009 and 2011 resulting in a 40% reduction in NOx emissions (**Figure 20**). The new emissions controls incorporate tangentially fired burners within the furnace enabling the employment of two techniques called "bulk furnace staging" and "early controlled coal devolatilization." These advanced processes reduce the amount of NOx emissions by first controlling the air available at the beginning of the combustion process, then controlling the flame

characteristics of the burners. Combustion optimization in the boiler to reduce emissions is further enhanced using advanced neural network technology to balance the different EPA emission requirements and also to minimize heat rate degradation.

Figure 20 - Low NOx Burners and SOFA.



Mercury and Air Toxics Standards Emission Control

Current and Planned Operations through 2019

The MATS rule published on February 16, 2012 (40 CFR Parts 60 and 63, Vol. 72, No. 32), regulates emissions of hazardous air pollutants from new and existing coal- and oil- fired electric utility steam generating units. The MATS rule sets emissions limitations for trace minerals, acid gases, mercury and organic compounds.

The mercury control system uses calcium bromide as coal additive to oxidize the mercury where it becomes water soluable. The mercury is then removed in the FGD absorbers assisted by the addition of powdered activated carbon to help sequester the mercury and minimize re-emission. These materials are trucked in and require on-site storage. On-going operation and maintenance of the systems needed to control for MATS will continue.

Other Emission Control

The owners of the Navajo Project will continue to operate, maintain, replace and improve systems and procedures to remain in continuous compliance of all current and future applicable regulatory requirements.

OIL AND CHEMICAL STORAGE

Current and Planned Operations through 2019

Various oil products and chemicals used in NGS operations are stored at locations throughout the plant site. Storage tanks range in size from 100 gallons to more than 5 million gallons of fuel oil (**Table 3**). Oil storage includes diesel, gasoline, turbine lube oil, transformer oil, antifreeze, and used oil products. Stored chemicals include sulfuric acid, sodium hydroxide, ammonia, ferric sulfate, sodium hypochlorite, scale inhibitor, and acid/caustic chemicals. In addition, NGS contains multiple, oil-filled transformers, including one for each power plant unit, an auxiliary step-down transformer, the MSS and RSS transformers in the 230-kV switchyard, and multiple smaller transformers. The oil in the transformers provides electrical insulation and cooling.

NGS's SPCC Plan contains measures used to prevent oil discharges from occurring and actions for responding to a spill in an effective and timely manner to mitigate the impacts of any discharge to a navigable water of the United States (SRP 2013). Actions in the SPCC Plan include preventative maintenance of equipment and containment and discharge prevention systems; annual employee training; and monthly inspections. The SPCC Plan includes EPA reporting requirements if a discharge exceeds a given amount. The SPCC Plan is reviewed and updated at least once every five years and within 6 months if there is a change in facility design or operation that materially affects the facility's spill potential.

Table 3 - On-Site Oil and Chemical Storage.

Substance	Storage Tank Size (gallons)	Number of Locations	Storage Locations
Oil Storage			
Diesel	100 to 5,000,000	28	Fuel tank storage, railroad loop, heavy equipment storage, north of central yard, mobile equipment
Mobile diesel	200 to 400	7	Various locations for equipment
Gasoline	100 to 12,000	3	Heavy equipment facility and fueling truck
30 wt engine oil	550	3	Heavy equipment facility
10 wt engine oil	550	3	Heavy equipment facility
Turbine lube oil	650 to 7,450	9	Power block units
H2 seal oil	650	3	Power block units
Transformer oil	5,600 to 5,750	3	Railroad loop
Lube oil	300 to 16,000	5	North central yard, power block, various locations
Used lube oil	16,000	1	North of Unit 1
Used oil	550-2,500	2	Heavy equipment facility
Used oil	100 to 500	3	Heavy equipment
Used fuel	500	3	Bottom ash units
Antifreeze	550	1	Heavy equipment facility
Waste antifreeze	1,000	1	Heavy equipment facility
Chemicals			
Calcium Bromide	30,000	2	South of the coal yard bin
Calcium Bromide	1,500	3	Power block units
Powdered Activated Carbon	44,000	1	East of scrubber air compressor building
Sulfuric acid	10,000 to 20,000	5	Water treatment, power block, cooling towers
Sodium hydroxide 25%	10,000	1	Power block units
Sodium hydroxide 50%	10,000	1	Power block units
Ammonium hydroxide 19%	10,000	1	Power block units
Ferric sulfate 65 %	40,000	1	Water treatment
Sodium hypochlorite 13%	4,500	3	Cooling towers
Scale inhibitor	2,000	6	Cooling towers

Ongoing operation, maintenance, replacement and improvement of the systems needed to safely and efficiently store oil and chemicals will continue.

WASTE MANAGEMENT

Waste management includes disposal of waste from power-generating activities. NGS operates and maintains on-site landfills used to store solid waste, asbestos containing material, and coal combustion residuals, fly ash, bottom ash, and FGD-gypsum. NGS also operates, maintains, and improves systems for wastewater management and sewage treatment. Solid waste materials are also transported off-site for disposal or recycling.

The primary waste management facilities at NGS are described in the following sections.

Landfills

Solid Waste Landfill

NGS utilizes waste minimization practices. Salvage materials include used equipment, instrumentation and office furniture. Recycle materials include paper products, scrap metal, wood, fly ash, aluminum cans, plastic bottles, printer cartridges, electronic waste, fluorescent lights, rechargeable batteries and tires.

Service contracts are used to stage trash dumpsters throughout the plant site and when full to transport the waste material to off-site landfills. The amount of material sent to the NGS solid waste landfill decreased over the years and in 2015 the landfill was closed for general use.

Current and Planned Operations through 2019

Site Layout. The solid waste landfill is located east of the railroad loop (**Figure 22**). The disturbed area encompasses about 13 acres including several terraces on the east slope of the mesa. In 2015, a new policy was implemented so that 100% of solid waste materials would be handled by outside vendors.

Closure and Post Closure. When the NGS landfill is permanently closed, a written closure plan will be developed based on federal best available controls technology (BACT) guidelines at the time. At a minimum the closure plan will:

- Apply final cover to the landfill.
- Ensure that cover is applied in such a way as to promote rapid runoff of water without excessive erosion.
- Verify that the cover is applied so that surface water runoff will not leave NGS property.
- Ensure that the cover is applied so that surface water never collects on the surface of the landfill.

Asbestos Landfill

The NGS asbestos landfill is currently managed as a permitted landfill under EPA regulations to dispose of asbestos-containing material generated during abatement or demolition activities. Per the extension lease agreement the contents of the existing asbestos landfill will be removed to a new offsite landfill. The asbestos landfill will continued to be used until remediation activities begin. The closure of the asbestos landfill could occur prior to the December 2019 plant closure.

Current and Planned Operations through 2019

Site Layout. The asbestos landfill is southeast of the railroad loop (**Figure 21**). The 3-acre landfill perimeter is secured with fencing and gated entrance. The fence and gate have signs indicating the asbestos landfill is a restricted area. Currently, less than half of the site is active or disturbed. Native vegetation is present on the inactive portion of the landfill.

Disposal of Asbestos-containing Material. The NGS asbestos landfill only accepts asbestos containing material generated from the plant site. The asbestos landfill cells are 24 feet by 30 feet by approximately 4 feet deep. Perimeter stakes are used for orientating the cellblocks. Depending upon the amount of waste material deposited, an individual cell may consist of a single material, but more typically, a cell contains waste from several disposal activities.

Handling of Asbestos-containing Material. The transfer of asbestos containing material into the asbestos landfill is coordinated by the NGS environmental department and heavy equipment operators. The transportation and handling of asbestos-related debris is conducted using NGS heavy equipment. In 2014, NGS disposed of 24 cubic feet of asbestos-containing materials in the landfill. The 5-year average from 2008-2014 was 124 cubic feet.

- For small volumes, the asbestos- containing material is wetted and double bagged using 6-mil polyethylene bags.
- For large pieces of asbestos-containing materials that do not fit into standard disposal bags, the material is wrapped in two layers of polyethylene sheeting and sealed with duct tape.
- For large pieces of non-friable material, such as electrical cable, the exposed (cut) ends of asbestos-containing material is taped prior to transportation and disposal.

Asbestos Disposal Cover.

- At the end of each operating day, or at least once every 24-hour period while the site is in continuous operation, the asbestos-containing material deposited at the site during the operating day or previous 24-hour period is covered with at least 6 inches of compacted non-asbestos-containing material.
- Once the asbestos debris has been covered with soil, no excavation or other disturbance of the asbestos waste is done without EPA notification.

Figure 21 - Solid Waste and Asbestos Landfills.

Coal Combustion Residuals (CCR) - Ash Disposal Landfill

Closure and Post Closure. When the asbestos landfill is permanently closed, a written closure plan will be developed based on federal BACT guidelines at the time. At a minimum the closure plan will:

- Ensure that cover is applied in such a way as to promote rapid runoff of water without

excessive erosion.
- Verify that the cover is applied so that surface water runoff will not leave NGS property.
- Ensure that the cover is applied so that surface water does not collect on the surface of the landfill.

Asbestos Monitoring and Reporting. The EPA administrator is notified in writing at least 45 days prior to excavating or otherwise disturbing any asbestos-containing waste material previously deposited at a waste disposal site and is covered. NGS environmental department personnel conduct monthly landfill inspections and take corrective action as needed.

Use of the asbestos landfill has varied with the amount of new construction, demolition, and renovation activities. Only asbestos-containing materials generated on-site are disposed of in the asbestos landfill.

The ash disposal site located 1.5 miles east of the NGS facility is regulated as an existing Coal Combustion Residuals (CCR) landfill under the CCR federal rule promulgated on April 17, 2015 and effective on October 19, 2015. Current and planned actions by SRP to comply with the CCR rule is summarized in **Appendix B**.

Current and Planned Operations through 2019

Unused coal combustion residuals (i.e., fly ash, economizer ash, bottom ash, and FGD-gypsum byproduct) are secured in a dry disposal site. Handling of these materials is performed by Headwaters Inc., currently under contract through 2016. Headwaters Inc. loads all trucks for delivery of fly ash, bottom ash, and byproduct wastes that are not destined for off-site recycling to the ash disposal site.

Ash Disposal. Three different types of coal ash are created in NGS boilers, each of which is handled in a different way before disposal. Bottom ash is heavy ash that falls to the bottom of the boiler. Economizer ash is light ash that gets carried part of the way through the boiler and falls out of the gas stream in the economizer section before it leaves the boiler. Fly ash is the lightest ash that gets carried out of the boiler in the flue-gas stream and is collected in the precipitators.

Each of these ash types ends up in an interim location before transport to the ash disposal site or off-site for recycling. Bottom ash falls into three separate but connected hoppers underneath the boiler where it is eventually crushed, then conveyed via a sluice water system

to one of two dewatering bins for that unit (**Figure 22**). Following dewatering, the material is loaded into trucks for transport to the ash disposal site located about 1 mile east of the generating station (**Figure 24**).

Economizer ash falls into the economizer hopper just under the economizer section of the boiler. The ash is then crushed at the bottom of the hopper and then conveyed to a tank located in the bottom ash bin area (**Figure 22**). The economizer ash is then sluiced to the dewatering bins. Following dewatering, the material is loaded into trucks for transport to the ash disposal site.

Fly ash is taken from hoppers under the precipitators and then conveyed through a pneumatic line to one of two fly ash bins. Fly ash is either sold for recycling off-site (**Figure 23**) or transported to the ash disposal site. NGS sells as much fly ash as possible to Headwaters Inc., who uses two trailer belly dump semi-tractor trucks to deliver to facilities located near Las Vegas, Nevada; Salt Lake City, Utah; and Tucson, Arizona. Currently, about 350,000 to 500,000 tons or 50% to 90% of the fly ash generated at NGS is recycled annually depending on market demand. Off-site trucking of fly ash for recycling in 2013 averaged about 775 to 800 trucks per month.

SO_2 scrubber solid waste in the form of FGD-gypsum is also transported by truck to the ash disposal site. The FGD-gypsum contains approximately 12% moisture with the majority of the water reclaimed through a vacuum belt filter. The filter filtrate solution is accumulated in a filtrate tank and recycled back into the limestone grinding process. The remaining dry FGD- gypsum material is then transported to the ash disposal site since there is currently no economical local market for wallboard or agricultural uses.

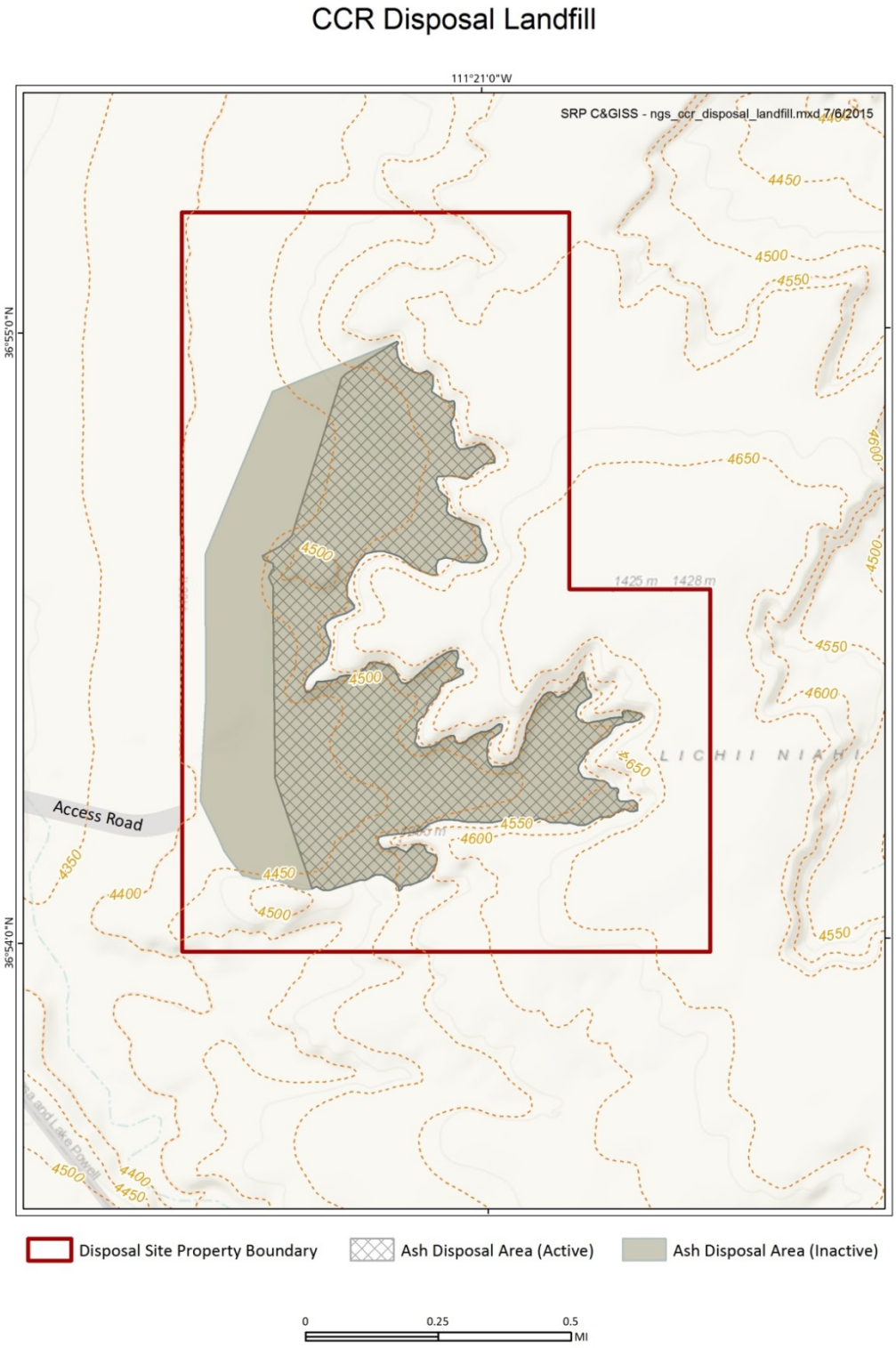
Figure 22 - Ash and Dewatering Bins.

Site Layout. The ash disposal landfill for CCR is located about 1.5 miles east of the generating station against the western edge of a mesa outcrop (**Figure 24**). The CCR material is deposited in horizontal terraces against the steep vertical walls of the sandstone outcrop. The western edge of the embankment is constructed as a series of small terraced fills to contain storm water runoff within the ash disposal embankment. The use of dry disposal in conjunction with the dry climate and geology of the region reduces the mobility and leachability of any of the coal constituents. Furthermore, the retention of stormwater runoff, dust control, and groundwater monitoring procedures regulated under the federal CCR rule are used to ensure containment of the CCR constituents.

Figure 23 - Fly Ash Loading.

The ash disposal site is 765 acres with a design capacity of 38 million cubic yards. The current planned landfill footprint encompasses approximately 400 acres. The disposal area was designed for fly ash, economizer ash, bottom ash, and scrubber byproducts. The original layers of fly ash and bottom ash were placed as engineered fill and compacted with a sheep's foot vibrating compactor at optimum moisture. Recent borings indicate those original layers are the strength of lean concrete causing boring refusal (see **Appendix F**).

Figure 24 - CCR Disposal Site.



An earth embankment was constructed across the entrance to the box canyon to facilitate CCR retention and placement as an engineered fill, and capture and retain stormwater runoff (**Figure 25**). Terraced slopes within the ash disposal site are shown in **Figure 26**. The ash disposal site contains areas of active disturbance and undisturbed areas that support native vegetation.

CCR Placement and Cover. Handling and transportation of coal combustion residuals to the ash disposal site is performed by Headwaters Inc., which loads all trucks for delivery of fly ash, bottom ash, and scrubber byproduct (FGD-gypsum) that are not destined for off-site recycling. Depending on market conditions, about 50% to 90% of the fly ash is transported off-site by Headwaters Inc. for recycle use. Headwaters Inc. meets all applicable compliance contract conditions and amenability with federal, state and local regulations regarding transport of the material. **Table 4** indicates the amount of material that was sold off-site and that was transported to the CCR disposal site in 2014.

Table 4 - CCR Disposal in 2014.

Material Type	Tons
To Ash Disposal Site	
Bottom & Economizer Ash	173,394
Fly ash & Economizer Ash	295,246
Scrubber Byproduct	458,048
Sold Off-Site	
Fly Ash	380,739

About 50% to 90% of the fly ash waste generated, depending on market conditions, is sold to Headwaters Inc. and is transported off-site. Headwaters Inc. meets all applicable compliance contract conditions and amenability with federal, state and local regulations regarding transport of the material.

At the ash disposal landfill, the following procedures are used for site preparation and disposal.

Site Preparation.

- The initial bottom layer of CCR material is placed on/against the sandstone bedrock or on compacted dune sand formations.
- The embankments of the terraces are constructed in layers or lifts not to exceed 15 vertical feet. The embankment foundation and every lift of storage material involve the steps of placing, spreading/grading, watering, and compacting, with the final top layer being covered with a 2-foot-thick layer of native soils.
- The resulting embankments are benched onto the adjacent natural ground and the bench areas are sloped to divert or minimize runoff (**Figure 26**).

Figure 25 - Front Face of Ash Disposal Berm.

Figure 26 - Terraced Slopes of Ash Disposal Berm.

Disposal Practices. All three CCR materials contain moisture when they are hauled to the disposal area including fly ash which receives water from the pug mills.

- The CCR materials are belly dumped from haul trucks into alternating 18" rows forming rows of FGD-gypsum, fly ash, and bottom ash.
- The rows are bladed over and compacted.
- Water is added as necessary to form a wind-resistant crust.

Monitoring and Reporting. Headwaters Inc. provides a monthly summary to SRP on the amount of materials hauled off-site, stored on-site, and water usage. NGS environmental department personnel conduct weekly landfill inspections per CCR regulations and corrective actions are taken as needed.

Ash Landfill Inspection. The CCR landfill is inspected by a qualified person at intervals not exceeding seven days for any appearances of actual or potential structural weakness and other conditions which are disrupting or have the potential to disrupt the operation or integrity of the landfill.

In addition, the CCR landfill is inspected annually by a qualified professional engineer to ensure that the unit is designed, constructed, operated, and maintained in a manner consistent with recognized and generally accepted good engineering standards and the qualified professional engineer must prepare a report following each inspection. If a deficiency or release is identified during the inspection, the owner/operator must remedy the deficiency or release as soon as feasible.

CCR Groundwater Monitoring System. A deep well groundwater monitoring system is being installed and groundwater samples are collected from the uppermost aquifer. This system will monitor both upgradient and downgradient groundwater quality to comply with CCR regulations by October 17, 2017 (see **Appendix B**).

The ash disposal site would continue to receive fly ash, economizer ash, bottom ash, and scrubber byproducts generated on-site.

In 2014, the volume of disposal material in the current ash disposal footprint was calculated at 18 million cubic yards with a remaining capacity of 19 million cubic yards. The ash disposal capacity is sufficient for disposal of fly ash generated through 2019.

Disposal of Other Waste Materials

Current and Planned Operations through 2019

As previously discussed, waste materials generated by NGS operations and, not disposed of in on-site landfills, are transported off-site to an appropriate landfill or recycling facility using independent contractors. NGS also recycles all on-spec used oil using an approved recycling vendor off-site. Waste generated in 2014 and averaged over five years is shown in **Table 5.** NGS would continue to contract transport of certain solid waste products for disposal at appropriate off-site locations.

Table 5 - Annual Waste Material Quantities and Disposition.

Waste Stream	Average Annual Amount over a Five-Year Period (2010-2014)	Annual Amount Generated (2014)	Ultimate Disposition/Site	Transportation
Solid Waste (Non-RCRA)	Not Available	3,848 cubic yards	Washington County Landfill	Republic Services
Solid Waste (Non-RCRA)	Not Available	< 1,000 cubic yard (estimated)	NGS Solid Waste Landfill (inactive in 2015)	**N/A**
Asbestos-containing Material	135 cubic feet	24 cubic feet	NGS Asbestos Landfill	**N/A**
Used Oily Rags	23.1 tons	19.2 tons	Subtitle D Landfill/ Waste Management – Butterfield Landfill	MP Environmental Services, Inc.
Arsenic Treated Cooling Tower Wood (exempted wastes)	1.53 tons	0 tons	Subtitle D Landfill/ Waste Management – Butterfield Landfill	MP Environmental Services, Inc.
Hazardous Wastes (e.g., lab wastes, mixed solvents, and oil-based paint)	3,165 pounds	1,274 pounds	Clean Harbors – Aragonite, UT (incineration) and Grassy Mountain, UT (Subtitle C landfill); Veolia, Port Arthur, TX (incineration); US Ecology, Beatty, NV (Subtitle C landfill)	MP Environmental Services, Inc.
Used Oil	11,677 gallons	17,120 gallons	Recycled with Thermofluids	Thermofluids
Universal Wastes (e.g., lamps, batteries, and mercury-containing equipment)	• 820 pounds of lamps • 153 pounds of batteries • 957 pounds of mercury-containing equipment	• 1,385 pounds of lamps • 114 pounds of batteries • 142 pounds of mercury-containing equipment	Recycled with Veolia, Phoenix, AZ	Veolia Phoenix
PCB Electrical Equipment	1,057 kilograms	920 kilograms	Clean Harbors – Aragonite, UT (incineration) and Grassy Mountain, UT (Subtitle C landfill); Veolia, Port Arthur, TX (incineration); US Ecology, Beatty, NV (Subtitle C landfill)	MP Environmental Services, Inc.

HAZARDOUS WASTE

Hazardous Waste Minimization Plan

Current and Planned Operations through 2019

As a Small Quantity Generator (SQG), NGS implements a Hazardous Waste Minimization Plan using the best available and affordable waste management methods to minimize waste generation. Waste minimization includes a number of actions including eliminating and minimizing waste at the source, recycling, reclaiming, reusing material, and training. Waste minimization actions encompass a variety of techniques – technology or process modifications; redesign of products; substitution of raw materials; and improvement in work practices (e.g., product and inventory control). An example includes the proactive screening of Safety Data Sheets prior to any job activity or the purchase of new chemicals. Chlorinated solvents are eliminated or minimized during this process. Contractors are also trained to properly plan chemical purchases to avoid unnecessary waste products. NGS employees are also trained in regard to waste minimization practices and applicable environmental regulations.

Annual waste generation at NGS has decreased substantially from 39,000 pounds in 1991 to about 1,274 pounds in 2014. NGS would remain proactive in minimizing or eliminating hazardous waste generation.

Wastewater Management

Current and Planned Operations through 2019

A series of inter-connected wastewater holding ponds are used to store, transfer, reclaim, and evaporate process water. Groundwater protection measures are used to prevent and monitor leakage from wastewater ponds. Sewage is processed in a step-aeration activated sludge treatment plant. Hazardous material generation is minimized with measures to recycle materials as feasible. The treated sewage effluent water is chlorinated and reclaimed back to water treatment influent for reuse.

NGS was designed to be a zero liquid discharge (ZLD) facility, meaning that all water brought into the plant site is reclaimed and reused and there are no liquid water discharges from the plant site. Wastewater processing facilities were designed to recover and recycle all cooling tower blowdown water and runoff from the developed area of the facility. Wastewater is

processed through brine concentrators and a crystallizer, which remove the solids and reclaim water for reuse in the plant. Lined ponds are used as part of the system to capture and regulate wastewater flow. Process water with increasingly greater concentrations of dissolved solids is pumped through these systems, as well as from other auxiliary plant systems.

In order for NGS to accomplish ZLD, it was originally planned that any wastewater generated by plant operations activities would be put into large evaporation ponds and that the evaporation rate would keep up with the wastewater stream produced. However, the evaporation rate was found to be insufficient to meet demand. To resolve this, Brine Concentrator (BC) #1 was built. BC #1 is a water recycling unit that takes wastewater with high dissolved solids and thermally evaporates it to produce two streams: 1) high-volume, low-dissolved solids condensate water that is reusable and 2) low-volume, high dissolved solids wastewater. Subsequently, NGS installed two additional larger BCs.

The wastewater stream from the BCs goes to the crystallizer, where it is further treated. The high-purity product water from the crystallizer is recycled and reused in the NGS circulating cooling water systems and the crystalized solid waste is disposed of in the lined salt disposal ponds. The BCs and crystallizer are integral parts of the overall NGS ZLD system. Prior to delivery to the BCs or crystallizer, most of the wastewater generated by the plant goes to intermediate storage ponds. Additional ponds are used for storing solid waste and for slurry sludge from the Water Treatment Reactivators (softeners). Most of the slurry sludge is used in the FGD process and helps minimize limestone usage. The wastewater management process is shown in the flow chart in **Figure 27** and the wastewater management pond locations are shown in **Figure 28.** The following is a detailed description of the operation of the various wastewater ponds.

Figure 27 - Wastewater Management Flow Chart.

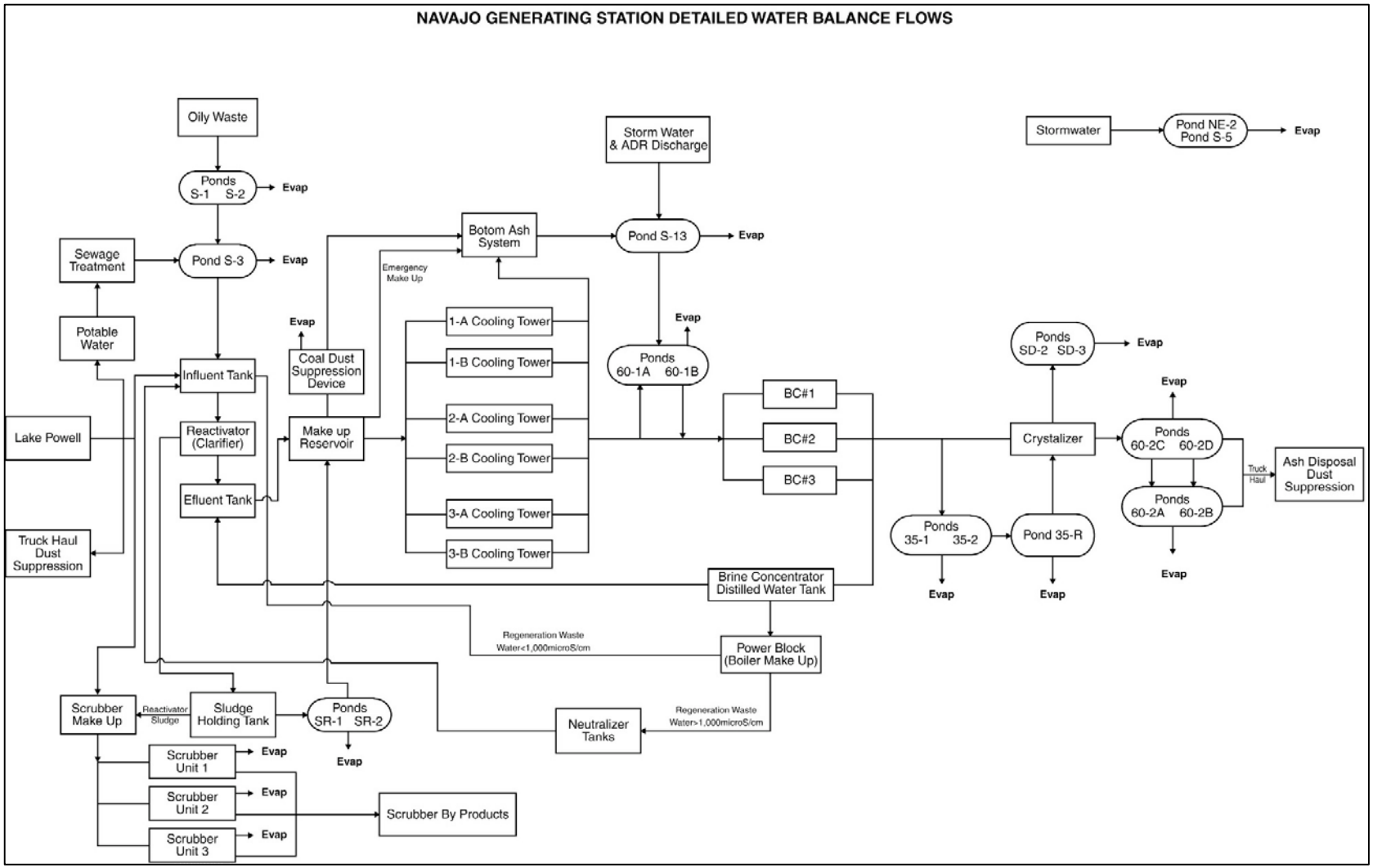


Figure 28 - Wastewater Management Ponds.

Wet Ponds.

- 60-series ponds are double-lined with leak detectors between and under the linings.
  - The 60-1 A and B ponds receive high dissolved solids water from concentrated cooling tower blowdown and stormwater runoff from the S-13 pond.
    - Water is pumped back to BCs for treatment and is then recycled for use in the plant.
  - The 60-2 A, B, C, and D ponds receive water containing high concentrations of solids flushed from the crystallizer when it is necessary to shut it down for maintenance activities.

        - Water goes either to the 60-2 C or D ponds where solids settle out. Liquid overflow goes to either 60-2 A or B ponds respectively, where it is evaporated. When either the 60-2 C or D pond fill with settled solids, the 60-2 D pond is put into use and 60-2 C pond solids are cleaned out and disposed of in the SD ponds and then relined.
- S-series ponds are double-lined.
    - S-1, 2, and 3
        - The S-1 and S-2 ponds receive water from unit sumps in the power block area that collects water from the floor drains throughout the power block. This water contains small amounts of oil. A siphon pipe in the ponds takes water from the bottom and directs it to the S-3 pond; this is done so that oil floating on the top will stay in the S-1 and S-2 ponds and be disposed of later instead of continuing on in the water system.
        - The S-3 pond receives water from the S-1 and S-2 ponds and also receives treated sewage effluent from the sewage treatment facility. Water in the S-3 pond is then pumped to the water treatment influent tanks where it is treated with incoming raw lake water and flows to the make-up ponds where it is used in various plant water systems.
    - Ponds S-5, S-6, S-7, S-8, S-9, S-10, S-12, and S-14 are shallow evaporation ponds that are no longer in service.
    - S-13 is a drainage pond that receives stormwater and ash ditch recovery water. There are capabilities to pump cooling tower water to S-13 to accommodate cooling tower maintenance. Water collected in S-13 can be evaporated or pumped to the 60-1 series ponds where it eventually becomes make-up to the BCs.
- 35-series ponds are either single lined or unlined
    - 35-1, 2, and R
        - The 35-1, 2, and R ponds are the receiving point for high dissolved solids water produced as a waste stream by the BCs that is to be further processed by the crystallizer. The BC wastewater flows directly to the crystallizer sump where it is either pumped directly into the crystallizer to be processed or overflows to another sump where it is pumped to the 35-1 or 2 pond. The 35-1 and 2 ponds overflow into the 35-R pond leaving solids behind. Water is pumped from 35-R back to the crystallizer to be processed as needed.
    - 35-3, 4, and 5
        - The 35-3, 4, and 5 ponds are native soil, unlined ponds that receive stormwater runoff.
    - Pond 35-6 is a single-lined pond that provided temporary storage to allow for 60-2 pond construction.
- NE-2 is a stormwater pond that is doubled-lined and collects drainage water coming from the east side of the plant and is supplemented by a small, earth-compacted detention basin to handle additional stormwater overflow, if necessary.
    - SR-1 and 2
        - SR-series ponds are sludge retention ponds, which are double-lined with leak detectors between and under the linings. During water treatment operations, a large amount of viscous high-calcium sludge is created. Normally, this sludge is sent to a sludge thickener tank and then pumped out for recycling and use in the

SO_2 scrubbers. When the sludge thickener tank is out of service, the sludge is pumped to the SR-1 or SR-2 pond where the solids settle to the bottom and the water left on the top is pumped back to the make-up water ponds to be used in the plant water systems.

Dry Ponds.

- Salt disposal ponds are double-lined with leak detectors between and under the linings.
  - SD-1, 2, and 3 are dry ponds where solid waste from the crystallizer is stored. Once the pond in use is filled, it is capped and monitored and the next pond begins to fill. The SD-1 and SD-2 ponds are closed. Room is available to expand and create more dry ponds when the need arises.
- The NE-1 and NE-SD are single lined ponds removed from service and capped.

NGS Groundwater Protection Plan (GWPP; see **Appendix C**).[5] The purpose of the GWPP is to ensure that water quality in the deep (900 feet) regional Navajo Sandstone aquifer is not impacted by past, current, and future plant operations (see **Appendix C**). The specific GWPP components include groundwater monitoring, formalized inspections and testing, engineering controls to avoid and minimize loss and transmission of plant water into the ground, measures to capture and reclaim water that has saturated soils, and implementation of additional best management practices for protecting groundwater.

Routine groundwater level and quality monitoring is in place for the three deep monitoring wells on the plant and ash disposal sites to assure protection of the deep aquifer. Recent improvements in engineering controls and monitoring have been implemented on several ponds. Additional pond liner system upgrades are scheduled in upcoming years on a prioritized basis. Installation and implementation of an extraction system for removal of shallow perched water from saturated soils beneath the main plant site began in May 2014.

Planning for the maintenance and operation of current and future ponds is an ongoing process to ensure that the wastewater management system remains safe and effective. New ponds may be constructed to facilitate the efficient operation of the zero liquid discharge facility. Any new pond constructed in the near term would be within the existing plant site and support the GWPP.

[5] GWPP and this section will be reviewed and revised as necessary to meet compliance with the Coal Combustion Residual Rule. It is NGSs intent to maintain both GWPP and CCR programs until October 17, 2017. At such time NGS will have a fully compliant CCR groundwater monitoring system in place along with required independent background sample and analysis and launched CCR semiannual detection monitoring. The duration of CCR groundwater monitoring is for thirty years post landfill closure.

Sewage Treatment Facility

The NGS wastewater treatment plant (WWTP) processes all sewage and gray water from toilets and sinks at the plant site. The WWTP is a Defiance Aerobic Sewage Treatment Extended Aeration System —Model 35 and is designed for minimum maintenance.

Current and Planned Operations through 2019

The raw wastewaters enter the sewage treatment plant directly into a series of aeration tanks.

The sewage wastewaters flow in series from one aeration chamber to the next. Organic solids break down and decompose over time, primarily by biological processes in the presence of bacteria. The bacteria in the floc use the organic material as a source of food. The resulting floc is the activated sludge. The activated sludge is separated from the liquid in the sedimentation tank and returned to the aeration tank.

The returning sludge maintains a sufficient number of active solids (bacteria) in the aeration tank. The solids that were not fully broken down before going into the settling tank are further used as food by the bacteria in the aeration tank. The sludge is returned from the sedimentation tank to the aeration tank using an airlift pump. Accumulated sludge is pumped out twice per year by subcontractors and hauled to an off-site sewage treatment facility.

No expansions or changes in the footprint of the existing WWTP are planned. The facility would continue to be maintained and operated similar to current conditions.

TRANSMISSION, SUBSTATION, AND COMMUNICATION SYSTEMS

Three 500-kV transmission lines transport energy from NGS (**Figure 1**) to points of delivery (McCullough, Moenkopi, Westwing, Yavapai, Cedar Mountain, Dugas, Morgan, and Crystal substations) for the NGS participants as specified in NGS operating agreements. SRP also maintains an approximately 225foot 230-kV line (which ties into Reclamation 230-kV power line from Glen Canyon Dam), and communication sites to operate NGS and the railroad. The transmission lines, substations, and communications sites also have independent utility because they are integrated into the western electric grid.

The Southern (STS) and Western (WTS) Transmission systems are maintained by APS and NVE, respectively, to provide safe and reliable transmission of energy to serve the NGS

Participant's customers. Operation and maintenance of the facilities requires periodic aerial and ground inspections, repair and maintenance of infrastructure, maintenance of access routes, and treatment of vegetation within the ROW corridors to meet federal and industry reliability and safety standards[6]. Line operators coordinate ongoing periodic line repair and maintenance and vegetation treatments with the appropriate land management agencies. In some areas of the STS on BLM and USFS ROWs, specific corridor management plans have been developed that describe in detail the utility O&M actions (**Appendix D**) and the procedures to avoid and minimize impacts to resources and the environment (APS 2008a, b, c, and APS 2011, and see **Appendix E**).

Table 6 provides a summary of transmission and communication infrastructure. The following provides a discussion of the sub-synchronous resonance yard, switchyards, substations, communication facilities, and the STS and WTS.

Table 6 - Transmission, Substations, and Communication Facilities.

Facility	Transmission Lines	Switchyard/Substations	Communication Sites	Operator
NGS and Railroad	1 - 230 KV power line	Sub-synchronous yard	• NGS Comm. Site • Preston Mesa • Zilnez Mesa	SRP
Southern Transmission System	2 - 500kv parallel power lines	NGS switchyard Moenkopi Switchyard Cedar Mountain substation Yavapai substation Dugas substation Morgan substation Westwing substation	• NGS Switchyard • Bill Williams • Jack's Peak • Moenkopi • Mt. Elden • Mt. Francis • West Phoenix • White Tanks • Westwing	APS
Western Transmission System	1 - 500 kV power line	Crystal substation McCullough substation	• Apex Peak • Beaver Dam • Buckskin Mountain • Glen Canyon • Glendale • Pipe Spring • Red Mountain	NVE[7]

[6] ANSI A300 Standards for Tree Care Operations: Tree Shrub, and other Woody Plant Maintenance (ANSI A300 Part 1 – 2001; ANSI A300 Part 7 - 2006), ANSI Z133.1 Standard for Tree Care Operations: Pruning, Trimming, Repairing, Maintaining, and Removing Trees and Cutting Brush – Safety Requirements (ANSI 2006), OSHA Regulations for Electric Power Generation, Transmission, and Distribution (29 CFR 1910.269), Pruning Trees Near Electric Utility Lines (Shigo 1990), National Electrical Safety Code (NESC 2007), Rural Utilities Service regulations (USDA 7 CFR Part 1738), Arizona Corporation Commission regulations, and Federal Energy Regulatory Commission (FERC) Mandatory Reliability Standards.

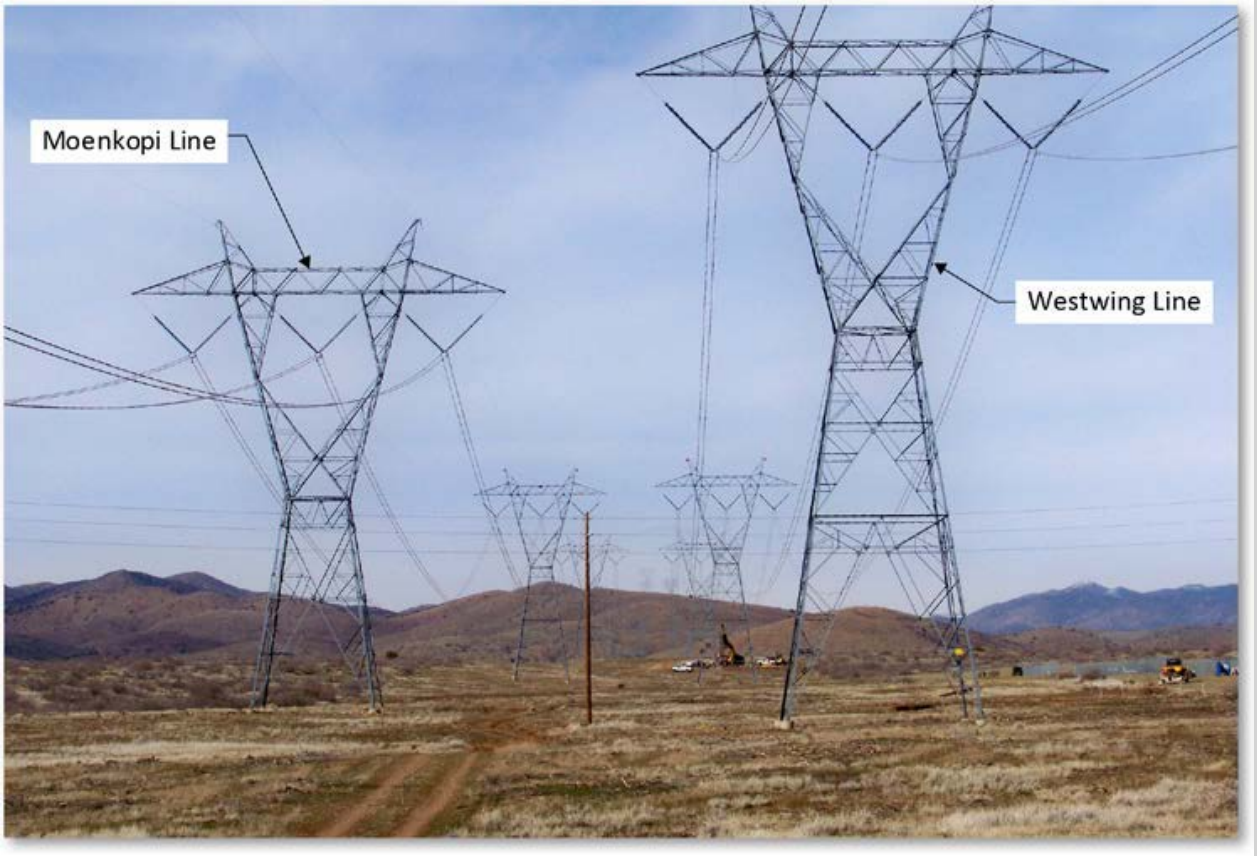
[7] NVE is responsible for all on-the-ground O&M of the facilities listed on the WTS except for the McCullough substation, which is operated by LADWP.

Southern Transmission System

The STS is operated and maintained by APS. This transmission line consists of two parallel, high-voltage transmission lines that begin at NGS with the eastern line called the Westwing Line and the western line called the Moenkopi Line (together the parallel lines are often referred to by APS as the "500-2" line). The Moenkopi Line connects to the Moenkopi Switchyard, and Cedar Mountain and Yavapai substations, and terminates at Westwing Substation. The Westwing Line connects to the Dugas and Morgan substations and terminates at the Westwing Substation (**Figure 29**). Except for a small segment near Moenkopi, the lines are within a common corridor (right-of-way). The total STS power line distance in Arizona is 257 miles and occurs across various land owners.

Figure 29 - Typical 500-kV Transmission Line Structures.

Southern Transmission System (Navajo to Westwing Line) near Dugas Substation, looking north



Western Transmission System

The WTS is administered by LADWP and on-the-ground operation and maintenance performed by NVE. The power line is a 500-kV transmission line (similar lattice structures as shown in **Figure 29**) that begins at NGS heads generally west across the Utah-Arizona border and into Nevada. From there it turns southwest to the Crystal substation located northeast of Las Vegas. It turns south at Crystal substation and continues to its terminus at McCullough substation. The total power line distance for the line is 275 miles and occurs across various land owners as shown in **Appendix A.**

Substations and Switchyards - NGS Transmission System Infrastructure

Sub-Synchronous Resonance Yard

Each of the three generating units has a Sub-Synchronous Resonance (SSR) Yard located on the generator output power lines. The SSR Yard consists of tuned filters that remove the three known sub-synchronous frequencies below 60 Hertz that can cause damage to the generator rotor if they travel back from the transmission system. Turbine generators have the potential to have an interaction between the electrical transmission system and the turbine generator rotor that may produce frequencies that set up harmonic resonances that can weaken and stress the rotor's metal structure. The SSR Yard is cleared and checked every minor overhaul by the relay department and repaired as needed. Each section of the SSR Yard can be cleared individually and repaired with the unit still in service, if problems occur between overhauls.

Southern Transmission System Substations

Five substations are interconnected to the STS. The specific infrastructure and equipment contained within each site varies, but generally each substation contains power transformers, switching devices such as circuit breakers and disconnects to cut power in case of a problem, and measurement, protection and control devices needed to ensure its safe and efficient operation. All sites have security fencing, and repairs and maintenance occurs within the existing footprint. Besides routine operation and maintenance, no changes to the substations are anticipated for operations beyond 2019.

Yavapai Substation

This substation is operated by APS. It is 21 acres with a 2 mile access road located approximately 12 miles east of Prescott Valley, Yavapai County, Arizona on USFS land.

Cedar Mountain Substation

This substation is operated by APS. It is located approximately 11 miles north of Williams, Arizona on private land.

Dugas Substation

This substation is operated by APS. It is located approximately 6.5 miles east of Mayer, Arizona on state land.

Morgan Substation

This substation is operated by APS. It is located approximately 5/8 mile south of Arizona State Route 74 and ¾ mile east of the Agua Fria River in northwestern Maricopa County, Arizona on state land.

Westwing Substation

This substation is the terminal point of the STS. The substation is operated by APS. It consists of 159 acres located between 119th Ave and 123rd Ave just south of Happy Valley Parkway in northwestern Maricopa County, Arizona on private land.

Western Transmission System Substations

Two substations are interconnected to the WTS. See STS substation section above for general description of infrastructure and operation and maintenance. Besides routine operation and maintenance, no changes to the substations are anticipated for operations beyond 2019.

Crystal Substation

This substation is owned and operated by NVE. It is located approximately 20 miles northeast of Nellis AFB in Clark County, Nevada. The substation is located on BLM land.

McCullough Substation

This substation is the terminal point of the WTS. The substation is owned and operated by LADWP. It is located approximately 14 miles southwest of Boulder City, Nevada. The substation is located on BLM land.

Moenkopi Switchyard

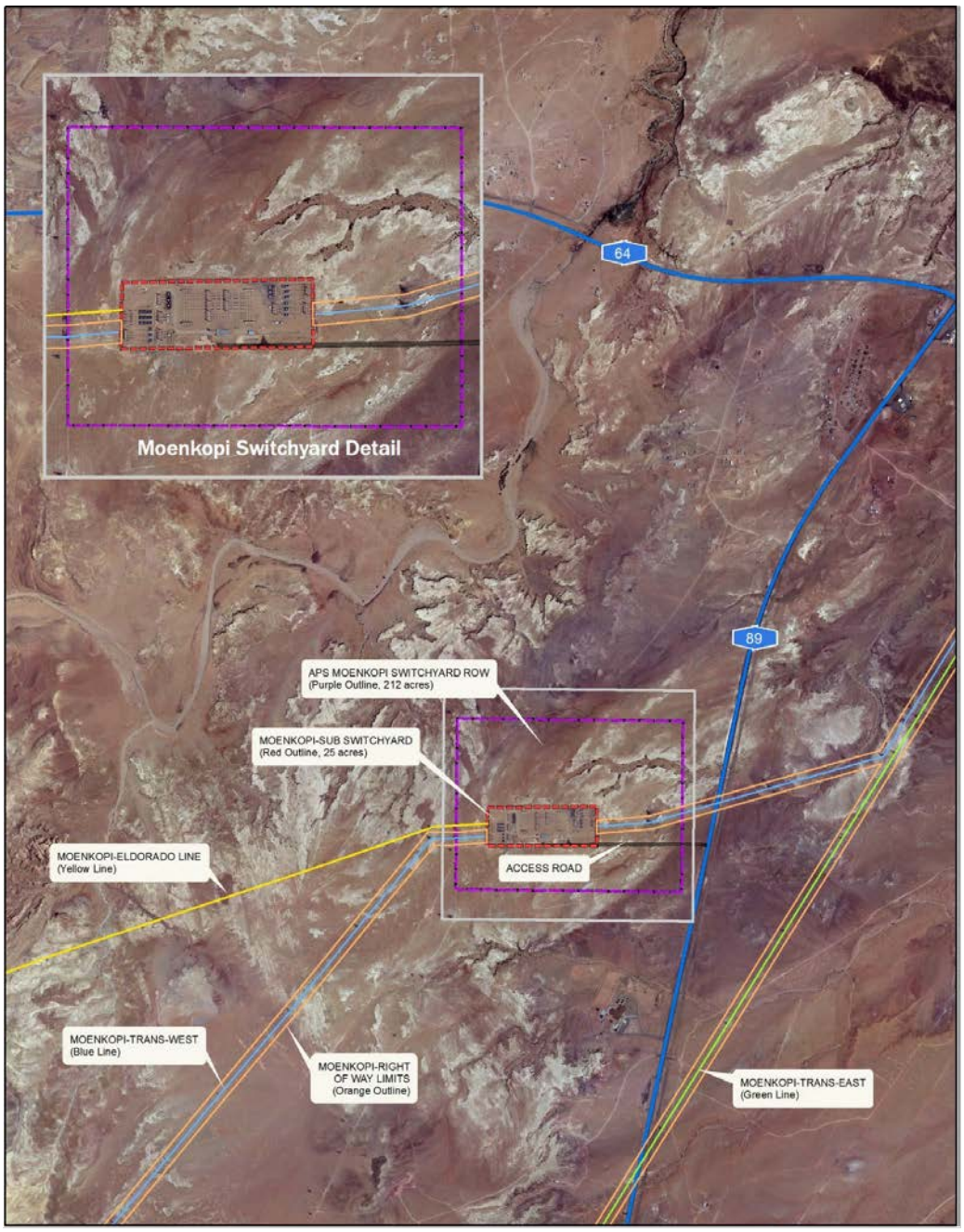
The Moenkopi 500-kV Switchyard and associated 12-kV line and access road are at 457 N. Highway 89 in Coconino County Arizona (**Figures 1** and **3**). APS is the operator of the Moenkopi Switchyard with several other entities having transmission rights through the switchyard. The 25-acre switchyard, within the existing (APS/FCPP) 212-acre ROW, has a 7-foot-high chain link fence with three strands of barbwire surrounding its perimeter. Entrance gates are kept locked at all times when unattended.

The switchyard provides an electricity grid interconnection point between four 500-kV transmission lines. The four 500-kV transmission lines connected to Moenkopi are the Four Corners to Moenkopi line, the Navajo Generating Station to Moenkopi line, the Moenkopi to Eldorado Substation line, and the Moenkopi to Yavapai Substation line. A 12-kV line provides station power to the Moenkopi Switchyard (**Figure 30**). The Moenkopi Switchyard contains capacitor banks and reactors to balance the transmission lines.

Communication Sites

The Navajo Project uses 19 sites for radio communication to operate the plant, railroad, and transmission systems, which are described below. The communication sites are either remotely located or within the boundaries of the plant or substations. Plant and substation sites have redundant power to back up the communication equipment. The remote sites have propane fueled backup generators that provide backup power for the equipment. Remote sites are fenced in. Many of the sites (as described below) are co-located with other users, and operation and maintenance, installation and replacement of equipment and access is coordinated with other users.

Figure 30 - Moenkopi Switchyard.



Inspections, maintenance, and repair of the communication sites are conducted on an as-needed basis. Typical maintenance activities includes: building and antenna structure repair and maintenance, clearing of vegetation within the site grounds, and at fence line to prevent fires, roof repair and replacement, replacement of weathered cables, repair and replacement of antennas and antenna towers, including painting, and repair of access roads.

NGS Communication Site (railroad, STS, and WTS)

This site is just above NGS Units 1 and 2 Control Room and is operated by SRP. The communication equipment is operated by SRP.

Preston Mesa Communication Site (railroad and STS)

This remote site is located on Navajo Nation land in Coconino County, Arizona about 36 miles south of NGS and southwest of Kaibeto, Arizona on Preston Mesa (**Figures 1** and **2**). The site supports a remotely operated communications antenna facility comprised of an approximate 200-square-foot building housing communication equipment. The facility's antenna is mounted on an adjacent tower that is shared with other communication facilities. Underground telephone cable provides connection to the NTUA/Western Area Power Administration facility located just to the west. This line provides a link to the repeater, which APS transmits back to the NGS base station for operation of the STS. The site borders undeveloped native vegetation and is accessed by an unpaved road. No chemicals, petroleum products, or hazardous substances are stored at the facility. This site is operated and maintained by SRP and APS.

Zilnez Mesa Communication Site (railroad)

This communication site is located on Navajo Nation land in Navajo County Arizona about 40 miles southeast of NGS (**Figures 1** and **2**). The site supports a remotely operated communications antenna facility comprised of an approximate 300 square-foot building housing communication equipment and an antenna. An emergency generator and approximate 500-gallon aboveground storage tank containing propane to operate the generator is located on the south side of the building. The site borders undeveloped native vegetation and communication tower facilities owned by others.

The site is accessed by an unpaved road. No chemicals or hazardous substances are stored at the facility. Propane for the emergency generator is the only petroleum product on the site. This site is operated and maintained by SRP.

Southern Transmission System Microwave Communication Site Operations

<u>NGS Switchyard Communication Site (STS and WTS)</u>

This site is within the switchyard at NGS. The communications building and tower has equipment that serves both the STS and WTS. The radio microwave equipment is operated and maintained by APS and NVE.

Jack's Peak Communication Site (STS)

This site is about 18 miles southwest of NGS and is located at a joint use communication facility permitted by the Navajo Nation (**Figures 1** and **2**). The radio microwave equipment is operated and maintained by APS.

Moenkopi Substation (STS)

The communication equipment (tower and control room) is located within the Moenkopi substation yard. This is a multi-use site. The equipment is maintained and operated by APS.

Mt. Elden (STS)

This site is about 1 mile north of Flagstaff, Arizona (**Figure 1**) and is located at a joint use communication facility permitted by the USFS. The radio microwave equipment is operated and maintained by APS.

Bill Williams (STS)

This site is about 3.5 miles south of Williams, Arizona (**Figure 1**) and is located at a joint use communication facility permitted by the USFS. The radio microwave equipment is operated and maintained by APS.

Mt. Francis (STS)

This site is about 5 miles southwest of Prescott, Arizona (**Figure 1**) and is located at a joint use communication facility permitted by the USFS. The radio microwave equipment is operated and maintained by APS.

White Tanks (STS)

This site is about 6 miles west of Waddell, Arizona (**Figure 1**) and is located at a joint use communication facility permitted by the BLM. The radio microwave equipment is operated and maintained by APS.

West Phoenix (STS)

This site is in the APS West Phoenix Generating Station in Phoenix, Arizona (**Figure 1**). This is a multi-use site. The site is on private land and the radio microwave equipment is operated and maintained by APS.

Westwing (STS)

This site is within the Westwing receiving station (**Figure 1**). This is a multi-use site. The site is on private land and the radio microwave equipment is operated and maintained by APS.

Western Transmission System Microwave Communication Site Operations

Glen Canyon (WTS)

This repeater site is approximately 14 miles northwest of Page, Arizona situated in southern Utah (**Figure 1**). The site is on Utah School and Institutional Trust Lands Administration (SITLA) land. The communication equipment is on a tower that is operated by WAPA and is dedicated to the WTS. The communication site is 50' x 50' and has an access road that is 50' x 5600'.

Buckskin Mountain (WTS)

This repeater site is approximately 33 miles northwest of Page, Arizona situated in southern Utah (**Figure 1**). It is a multi-purpose site on BLM land and the radio microwave equipment is operated and maintained by LADWP.

Pipe Spring (WTS)

This is a microwave repeater site located Mohave, County, Arizona, approximately 12 miles southeast of Colorado City, Arizona on the Kaibab Indian Reservation (**Figure 1**). It is approximately 50 feet by 50 feet. There is a communications building and adjacent communication tower. The radio microwave equipment is operated and maintained by NVE, and serves additional communications needs.

Beaver Dam (WTS)

This repeater site is approximately 17 miles west-northwest of St. George, Utah (**Figure 1**). It is a multi-purpose site on BLM land and the radio microwave equipment is operated and maintained by LADWP.

Glendale (WTS)

This repeater site is approximately 24 miles southwest of Mesquite, Nevada, just north of I-15 (**Figure 1**). It is a multi-purpose site on BLM land and the radio microwave equipment is operated and maintained by LADWP.

Apex (WTS)

This repeater site is approximately 7 miles northeast of Nellis AFB, Clark County, Nevada located on private land (**Figure 1**). Apex is a very large multi-user ridge top with multiple users in multiple fenced sites, with a wide range of spectrum segments and purposes. Its use for the WTS is a minor incidental use inside the multi-purpose NVE site. There is a 2.76 mile access road serving the site that is periodically maintained by the various users.

Red Mountain (WTS)

This repeater site is approximately 2 miles north of Boulder City, Nevada (**Figure 1**). This is a multi-use site. The site is on a permanent easement in the City of Boulder, shared by SCE and NVE

Current and Planned Operations Past 2019

The need for repairs, replacement, and other preventative maintenance procedures to the existing NGS Project transmission, substation, and communication infrastructure would be based on the results of inspections or other utility reports. The following is a list of the transmission, substation, and communication system O&M activities according to their associated activity category. Generally, substation and communication site O&M are similar among SRP, APS, and NVE and all maintenance actions are restricted to the permitted ROW, which includes access roads, and within the existing fenced facility perimeter. Transmission line maintenance is required to meet common utility standards and regulations (see above), but the O&M programs and use of specific equipment and practices, may differ between APS and NVE based on the corporate policies and the environmental setting of transmission systems, which affects the need for type and frequency of maintenance actions (e.g., periodic ROW corridor vegetation treatments).

These activities are performed within the permitted ROW wherever damage, deterioration, or aging of transmission, substation, and communication site infrastructure or vegetation encroachment poses a threat to safety or reliability. Any work outside the permitted ROW (e.g., hazard tree removal, conductor pulling and tensioning sites, repair of access roads not identified in the easements, installation of culverts, etc.) require APS, NVE, or SRP, as appropriate, to

coordinate with and gain separate authorization, as necessary, from the applicable land management agency.

Tables 7 through **9** provide details of covered activities conducted within each of the O&M Categories identified below:

- **Category A – Inspection and Minor Maintenance Activities (Table 7)**. Category A maintenance activities are primarily inspection-type actions, with some minor repairs that would not cause substantial soil or other disturbance. Maintenance activities included in Category A are restricted to the existing fenced substation or facility perimeter. These maintenance activities may require use of light and heavy duty equipment such as helicopters, all-terrain vehicles (ATVS), pick-up trucks, bucket trucks, cranes, line trucks, and pole trucks.
- **Category B – Routine Maintenance Activities (Table 8)**. Category B maintenance activities include typical repair and corridor maintenance tasks that occur within permitted transmission line, substation, and communication site ROWs. These maintenance activities may require use of light and heavy duty equipment such as helicopters, bucket trucks, backhoes, front-end loaders, front-end loaders, graders, steel-tracked and/or rubber-tired bulldozers, cranes, auger trucks, bobcats, mowers, line trucks, and pole trucks.
- **Category C – Additions or Modifications to Existing Substation, Transmission, and Communication Infrastructure that require would require separate authorization from the appropriate Permitting Agency(s), and are not part of the proposed Navajo Project (Table 9)**. Category C tasks are generally those activities that would require substantial replacement or moving multiple steel lattice towers, work outside the ROW and identified (permitted) access roads, or modifications to existing equipment for purposes not associated with or required for operation the Navajo Project.

Table 7 - Category A Transmission System O&M Actions – Inspection and Minor Maintenance Activities within Permitted ROW.

Substation and Switchyard Maintenance	
• Building maintenance including interior and exterior painting; and roof, ceiling, floor, window, and door maintenance • Main station battery bank maintenance and installation • Clearing vegetation by hand or by mechanical means within the fenced boundary of maintenance facilities • Application of soil sterilants, herbicides within the fenced property boundary of maintenance facilities (requires separate pre-authorization for federal ROWS) • Application of registered pesticides and rodenticides inside buildings • Substation inspections • Maintenance and replacement of transformers and breakers • Servicing and testing of equipment at existing substations, including oil change-outs • Installation or replacement of bushings • Cleaning or replacement of capacitor banks • Maintenance or installation of switches (manual and motor-operated), interrupters, voltage regulators, reactors, reclosers, and valves	• Replacement of wiring in substations and switchyards • Replacement of existing substation equipment including regulators, capacitors, switches, wave traps, radiators, instrument transformers, and lightning arresters • Installation of cut-out fuses • Adjustments and cleaning disconnect switches • Placement of temporary transformer • Maintenance, installation, and removal of solar power array and controller • Installation of foundation for storage buildings aboveground mat within existing substation yard • Maintenance or installation of propane tanks within a substation yard • Installation and repair of footings • Ground mat repairs
Transmission Line Maintenance	
• Ground and aerial patrols • Climbing inspection and tightening hardware on steel transmission line structures • Ground wire maintenance • Installation, maintenance, and replacement of aircraft warning device maintenance (e.g., light beacons, aerial marker balls, etc.) • Insulator replacement and maintenance • Bird guard installation and maintenance • Hand removal and/or pruning of danger trees or vegetation	• Maintenance or replacement of steel members of steel transmission line structures • Installation of new communication lines (aboveground) and components necessary for operation of the NGS Project • Maintenance or replacement of hardware on steel transmission line structures • Ground rod maintenance • Armor rod maintenance and clipping-in structures • Conductor maintenance • Antenna maintenance • Structure mile-marker maintenance
Communication System Maintenance	
• Generator maintenance • Maintenance and inspection of microwave radio towers and dishes • Maintenance and inspection of communication towers, antennae, and appurtenant equipment • Panel additions and removals, wiring changes, and controls modifications	• Maintenance and inspection of parabolic dishes • Light beacon maintenance • Refilling of propane tanks, and maintenance of associated gauges and switches • Above-ground foundation and footings maintenance • Application of soil sterilants and herbicides within the fenced property boundary of maintenance facilities (requires separate pre-authorization for federal ROWS) • Application of pesticides and rodenticides inside buildings

Table 8 - Category B Transmission System O&M Actions - Routine Maintenance Activities within Permitted ROW.

Transmission Line Maintenance	
• Hand removal and/or pruning of trees or vegetation • Vegetation management within the ROW using application of approved herbicides by backpack-mounted sprayers or vehicle-mounted sprayer (requires separate pre-authorization for federal ROWS) • Mechanical vegetation management by means of masticators, mowers, or other mechanical equipment • Remove soil deposition around tower legs • Place fill or rock(s) around existing towers or structures • Tower footing maintenance • Ground anchors maintenance	• Vehicle and equipment staging • Installation and repair of fences and gates • Replacement of existing overhead power, communication, or ground electrical line • Installation of communication lines (aboveground) and components necessary for operation of the NGS Project • Erosion control projects within ROW that meet nationwide permit requirements • Maintenance of existing access roads within ROW
Substation, Switchyards, and Communication System Maintenance	
• Installation and repair of foundations or footings maintenance • Replacement and installation of underground and overhead power, communication, or ground electrical line • Installation or replacement of antennas to existing structures	• Maintenance of facility fences, gates, and drainage structures.

Table 9 - Category C Transmission System Activities that are not part of the proposed action and would require separate authorization from Permitting Agency(s).

• Creation or re-opening of access roads off permitted ROW • Erosion control projects at existing structures and facilities that do not meet nationwide permit requirements • Replacing or repair of existing equipment that requires ground disturbing activities or off-road travel outside the permitted ROW • Installation of rip-rap to recontour washes, creeks, or rivers	• Relocation of lattice towers within/or outside of ROW • Installation of new underground and overhead power, communication lines, or other components not necessary for operation of the NGS Project • Vegetation management using herbicides on federal ROWs

Southern and Western Transmission Line and Corridor Ongoing and Planned Maintenance

Maintenance of the Southern and Western Transmission Systems, including corridor vegetation management, are conducted in accordance to industry standards, regulations, and recommendations[8]. The Southern and Western Transmission Systems pass through very different terrains and vegetation densities. As such, the transmission line and corridor maintenance plans differ between NVE and APS. The description below summarizes the activities involved in maintaining the transmission line infrastructure and vegetation within the ROWs. Additionally,

[8] Industry standards, regulations, and recommendations governing maintenance: ANSI A300 Standards for Tree Care Operations: Tree Shrub, and other Woody Plant Maintenance (ANSI A300 Part 1 – 2001; ANSI A300 Part 7 - 2006), ANSI Z133.1 Standard for Tree Care Operations: Pruning, Trimming, Repairing, Maintaining, and Removing Trees and Cutting Brush – Safety Requirements (ANSI 2006), OSHA 1910.269 Regulations for Electric Power Generation, Transmission, and Distribution (29 CFR 1910.269), Pruning Trees Near Electric Utility Lines (Shigo 1990), National Electrical Safety Code (NESC 2007), Arizona Corporation Commission regulations, and Federal Energy Regulatory Commission (FERC) Mandatory Reliability Standards.

the utilities have agreed to specific best management practices, and mitigation and conservation measures, to avoid or minimize impacts to natural resources and the environment (**Appendix D**).

Due to the frequency and treatments needed on segments of the STS, APS has developed specific corridor management plans that describe in detail the vegetation management actions and line maintenance practices (**Appendix C**, and see USFS 2008). Except as noted below, the description of activities for the STS is based upon the APS corridor management plans and USFS (2008), and the WTS descriptions are based upon discussions with NVE.

System Inspections

APS and NVE conduct regular (at least once or twice a year) aerial, ground, and climbing inspections of existing infrastructure to check for hazard trees or encroaching vegetation, as well as to locate damaged or malfunctioning transmission equipment. Inspections may also be initiated by conditional factors, such as faults, wildfires, and other unpredictable events.

Aerial inspections are performed by helicopter to identify issues on the STS and WTS. Typically, aerial patrols occur between 50 and 300 feet above, and adjacent to the transmission line, depending on the land use, topography, and infrastructure requirements. APS conducts these aerial inspections annually (see USFS 2008) and NVE conducts their aerial inspections approximately every five years.

Periodic ground inspections of the STS and WTS would check access to the ROW, transmission structures and hardware, tree clearances, fences, gates, locks, and would ensure that each structure would be readily accessible in the event of an emergency. Ground inspections would allow for closer assessment of infrastructure not possible by air, and identify redundant or overgrown access roads that should be permanently closed and/or returned to their natural state. Ground inspections would typically be conducted by driving a pickup truck or ATV within the ROW and on access roads.

Climbing inspections are conducted on transmission line structures if aerial or ground inspections find problems. Typically, such activities would involve the use of a pickup truck, ATV, bucket truck, or helicopter to access the inspection site.

Vegetation Maintenance Activities

Vegetation management includes routine vegetation maintenance, removing and pruning hazard vegetation[9], and vegetation control around structures and other electric facilities. Vegetation management involves manual and mechanical treatment of vegetation, herbicide spot treatments, pre- and post-inspections of vegetation, and disposal of vegetation. The STS corridor is maintained to industry line clearance standards (see USFS 2008) using vegetation management treatments and currently support low-growing vegetation (e.g. grasses, forbs, desert scrub, sagebrush, sparse pinion-juniper). Areas with very dense or taller shrubs (e.g. dense interior chaparral) may be cleared to reduce fuel load and to maintain the existing roads within the ROW for vehicle access. Where needed, APS also maintains a 20 ft radius around steel footers free of shrubs, trees, or other such vegetation to provide a fire break to minimize arcing of electricity or burning of structures during a fire under or near the power line.

Due to the infrequent need for vegetation treatments, NVE does not have an established periodic routine maintenance program for vegetation maintenance on the WTS. The low growing and sparsely vegetated plant communities along the Western line do not result in the need for large-scale routine vegetation clearing. Vegetation maintenance is performed on an as-needed basis in response to annual variation in rainfall and species growth rates. Historically minor vegetation maintenance has been needed about every five years. Line maintenance is also conducted on an as-needed basis. The WTS primary access roads (see WTS access road maps submitted to Reclamation and BLM under separate cover) are maintained twice a year to permit line inspections.

Mechanical and Hand Clearing of Vegetation

Where approved for use on the STS (see below), herbicide treatments are the preferred method of treatment to maintain corridor vegetation. On the WTS, and areas on the STS that are not treated with herbicide, mowers and/or hand cutting is used to maintain vegetation within the rights-of-ways. Mowing equipment include tractors with a cutting device that mulch or cut vegetation and leave it in place (**Figure 31**). Hand crews work alongside of the mower or behind

[9] Hazard vegetation is alive or dead standing tree or vegetation having defects, singly or combined, in the roots, butt, bole, or limbs, which predispose it to imminent mechanical failure or arcing hazard to the whole or part of a utility line, pole, or tower (also see definition and explanation in USFS 2008).

the mower to address trees that the mower cannot treat and to cut any slash that was not masticated by the mower into smaller pieces. Hand crews are also used for vegetation removal in areas that have limited accessibility, where the terrain would not allow mowers or other machinery to operate safely (e.g., steep slopes), or to protect sensitive resources (e.g., listed plant species or archeological sites).

Vegetation is disposed of onsite per coordination with the appropriate land manager (see **Appendix D**). Land uses, terrain, aesthetics, fire concerns, archeological sites, and species concerns are considered to determine the most appropriate disposal method. The disposal methods may include broad casting chips from the mower (to no more than 4" deep), lop and scatter of larger limbs and trees, chipping of limbs and trees, cutting logs to firewood length, or piling of slash for later burning by the land management agency. No slash and logs are placed within 25 feet of the high-water mark of streams or other bodies of water, and all areas with the potential for flowing water (culverts, ditches, washes, etc.) are kept free of slash, logs, and debris from tree removal operations. Logs are not hauled off-site by the utilities.

Figure 31 - Example of Mowers Used by APS for Vegetation Maintenance of the STS.

Herbicide Spot Treatments (STS only)

Where approved, herbicide use is the preferred method of treatment to maintain corridor vegetation. APS periodically conducts herbicide spot treatments on Navajo Nation (see **Appendix D**), state, and private land ROWs along the Southern Transmission system. APS has requested approval from the USFS and BLM authorizing herbicide use on federal ROWs. The authorization on federal lands is subject to separate NEPA, ESA, and Section 106 compliance

processes by each agency, and if approved, would become part of the ongoing maintenance activities (current and post-2020 operations).

All herbicides that would be used have been approved by the United States Environmental Protection Agency (EPA) and USDA. APS applies herbicides using low-volume hand held or backpack sprayers and other ground-based equipment. Herbicide treatments would occur in selected locations within established utility ROWs, where vegetation had been previously maintained through the existing non-herbicide treatment program. ROWs are accessed from existing roads and routes. There would be no aerial herbicide applications.

Herbicide treatments, in combination with limited manual and mechanical treatments, occur approximately every 5 to 10 years, which is less frequent than the 1 to 5 year treatment cycle using mechanical and manual treatments only. Herbicide treatments also require less equipment and fewer workers compared to manual treatments and are shorter in duration. Over time, it is anticipated that herbicide treatments will convert ROW vegetation to compatible early successional plant species, which will outcompete the taller growing, undesirable species and reduce or eliminate the need for future manual, mechanical, and herbicide treatments.

Herbicides are applied from a backpack or a quad/ATV mounted sprayer using a spray wand, allowing for plant-specific treatments. The herbicide is contained in sealed pre-mixed “ready to use” formulations, and there is no chemical mixing on site. Targeted vegetation includes any species less than 10 feet tall whose physiology is such that it could potentially impact the reliability of the transmission line, the associated transmission facilities (e.g. towers, guy wires, etc.), or poses a fire fuel load concern. Typical vegetation to be treated include juniper (*Juniperus* spp.), oak (*Quercus* spp.), pine (*Pinus* spp.), Russian olive (*Elaeagnus angustifolia*) and saltcedar (*Tamarix chinensis*) trees less than 10 feet tall, or sagebrush (*Artemisia* spp.) and other shrubs at the base of towers or where their densities pose a fire fuel load concern

Chemicals and Rates

The low-volume herbicide application process would use a combination of EPA and USDA approved products and adjuvants, which aid or modify the action of the product. APS uses adjuvant ThinVert®, which is a paraffinic oil, because it requires less herbicide volume than when used with water. (Applications using ThinVert® are considered ultra-low volume.) The

herbicide formulation would vary as determined by licensed applicators but would follow label requirements. Typical mixtures using a non-water based carrier would be approximately 95 percent adjuvants and inert ingredients and 5 percent active herbicide ingredient. For example, a typical 10 gallon mixture, applied at the estimated rate of 2 to 3 gallons per acre, would include approximately 24 to 44 ounces of combined herbicide products to one acre of land. Application rates would vary depending on size of treatment areas but would not exceed those stated on manufacturers' labeling (**Tables 10** and **11**).

As noted above, the licensed applicator determines the most appropriate product to apply given the vegetation and environmental conditions, these may include but are not limited to:

Table 10 - Example of Upland Mix.

Chemical	Active Ingredient	Rate (% total volume)	EPA Registration #
Garlon 3A	Triclopyr	4%	62719-37
Milestone VM	Triclopyr & Aminopyralid	<1%	62719-572
Escort XP	Metsulfuron Methyl	<1%	352-439
Thinvert	Paraffinic Oil	94%	NA

Table 11 - Example of Riparian Mix.

Chemical	Active Ingredient	Rate (% total volume)	EPA Registration #
Habitat	Imazapyr	7%	241-426
Accord	Glyphosate	2%	62719-517
Thinvert	Paraffinic Oil	91%	NA

State and federal regulations tightly control herbicide use. These regulations are intended to ensure the safety of applicators, the public, and the general environment. APS implements several mitigation measures or SOPs designed to ensure human and environmental safety and efficient and effective herbicide treatments. In addition to the SOPs listed below, threatened and endangered species conservation measures also apply; these are found in **Appendix E**.

<u>General Standard Operating Procedures for Applying Herbicides.</u>

- Prepare an operational and spill contingency plan in advance of treatment.
- Select an approved herbicide that is least damaging to the environment while providing the desired results.
- Select herbicide products carefully to minimize additional impacts from degradates, adjuvants, inert ingredients, and tank mixtures.
- Apply the least amount of herbicide needed to achieve the desired result.
- Follow herbicide product label for use and storage.
- Have licensed applicators apply herbicides.
- Use only EPA-approved herbicides and follow product label directions and "advisory" statements.

- Review, understand, and conform to the "Environmental Hazards" section on the herbicide product label. This section warns of known pesticide risks to the environment and provides practical ways to avoid harm to organisms or to the environment.
- Minimize the size of application area, when feasible.
- Comply with herbicide-free buffer zones, if appropriate.
- Post treated areas and specify re-entry or rest times, if appropriate.
- Notify adjacent landowners prior to treatment, if appropriate.
- Keep a copy of Material Safety Data Sheets (MSDSs) at work sites. MSDSs are available for review at http://www.cdms.net/.
- Keep records of each application, including the active ingredient, formulation, application rate, date, time, and location.
- Avoid accidental direct spray and spill conditions to minimize risks to resources.
- Use drift control agents and low volatile formulations.
- Comply with biological assessments and opinions to avoid or minimize impacts to federally listed species and designated critical habitat.
- Consider site characteristics, environmental conditions, and application equipment in order to minimize damage to non-target vegetation.

Site Safety

All applicable labels, federal and state laws, and regulations with regard to the use and application of herbicides are followed. Applicators will wear the maximum PPE required per the label for each herbicide being applied including but not limited to long sleeved shirts and pants, gloves, socks, and boots. Those operating the quad/ATV mounted sprayers will also be required to wear goggles or safety glasses and helmets.

MSDS and labels will be on site at all times and all safety precautions listed on the product labels shall be strictly adhered to. Each crew will consist of licensed herbicide applicators and at least one crew member will have a minimum of three years of experience applying herbicides. Crews working on the project will have telephones, chemical spill kits, shovels, first-aid kits, fresh water, and emergency phone numbers with them.

Line Maintenance Activities

Line maintenance involves patrols and inspections to identify problem areas along the lines, structures, and hardware, and the repair and replacement of these problem areas for overhead lines. Equipment failure can result from a variety of causes including weather, overloaded conditions, vandalism, and aging infrastructure. Defects identified in the patrols and inspections

are prioritized and scheduled for repair based on the risk to human health and safety and system reliability.

Repairs and maintenance on transmission lines may include work on conductors, lattice tower structure, insulators, and all other supporting equipment and hardware. Problems that may be repaired are: replace flashed or broken insulators, tighten loose hardware, replace missing hardware, repair damaged conductor, replace or repair broken or loose ground wire connections, replace cut/stolen ground wires, repair twisted or damaged hardware, remove foreign objects, and repair structure foundation conditions. The life span for much of the power line equipment ranges from 30 to 60 years. However, repair on or replacement of the equipment may be needed at any time and the frequency of the work is difficult to predict.

Vehicles that may be used during the maintenance work include pickup truck, ATV, bucket truck, crane, backhoe, boom truck, caterpillar, snowcat (for high elevation snow conditions), cable puller trucks, and various trailer attachments with equipment. Large semi-trucks may also be used on major established roads to haul in equipment. Crews may walk in if no access routes are available, or helicopters are used to transport crews and equipment (e.g. replacement parts, conductor wire, etc.) into an area (infrequent occurrence, 1 -2 times a year). Infrequently (< once per year), erosion control is necessary at tower footings. A bulldozer or backhoe is often used to make the repairs, but if the area is not accessible, the work is done by hand.

Ongoing operation and maintenance of the systems would continue to support power generation, STS and WTS operations, and railroad operations through 2019. No reconstruction, major replacement, or other activities beyond continued operation and as-needed maintenance, replacement and improvement as described above is anticipated through 2054.

ACCESS ROADS

Existing permitted roads (identified in the existing easements and renewals), public roads, Navajo Nation roads, and other federal, state, county, local, and private roads are used to access NGS Project facilities and ROWs. Navajo Nation Lease[10] provides NGS Participants use of

[10] Indenture of Lease Navajo Units 1,2, and 3 between the Navajo Tribe of Indians and Arizona Public Service Company, Department of Water and Power of City of Los Angeles, Nevada Power Company, Salt River Project Agricultural Improvement and Power District, and Tucson Electric Power Company. 1969. [see §2.(c)]

access roads outside of leased lands for ingress and egress to NGS project facilities on the Navajo Nation.

Railroad Service Road

Current and Planned Operations through 2019

A dirt service road parallels the approximate 78-mile railroad from KM to NGS. The road is used to provide access for maintenance of the railroad and catenary system. Periodic grading and road maintenance is conducted as-needed. The road is closed to public access. No new roads or substantial upgrades are needed to support existing railroad service. Road maintenance would continue similar to current operations within the existing ROW.

NGS Access Roads

Current and Planned Operations through 2019

State Highway 98 from Page, Arizona provides access to NGS (**Figure 3**). Three spur roads off State Highway 98 access different sections of the NGS Plant site. A number of internal roads within the NGS site connect different facilities. Periodic maintenance of paved roads, including chip sealing and stripping, is conducted to ensure safe travel. Dust control on unpaved gravel roads within the NGS operations area is conducted daily using water from the make-up ponds.

New internal roads are possible but not currently planned at the NGS plant site. Road maintenance activities such as paving, grading, and drainage work would be conducted periodically as needed.

Lake Pump Station Road

Current and Planned Operations through 2019

Access to the pumping plant site is via a 3.6-mile unpaved gated road off Navajo Nation Route 222 (**Figure 3**). The lake pump station road[11] is one-lane. Periodic maintenance activities on the one-lane are conducted to provide safe driving conditions. In addition, a maintenance road and power line are located within the same ROW as the pipeline.[12] This road is not regularly maintained, but provides occasional access for maintenance and inspection of the water pipeline.

[11] Lake pump station road is referenced as "Road between Pump Station and N228" in the lease between SRP and the Navajo Nation.

[12] The ROW containing the pipeline and road is referenced as the "Piping and Road between Plant Lake Pump" in the lease between SRP and the Navajo Nation. The power line in the same ROW is referenced in the lease as "Power Line to Lake Pump."

Periodic road repairs and maintenance would be conducted for the lake pump station road. No new disturbances outside of the existing ROW are anticipated.

Ash Disposal Road

Current and Planned Operations through 2019

An approximately 1-mile-long dirt haul road connects NGS and the ash disposal site to the east. The ash disposal road[13] is fenced to keep grazing animals off the road. Water from the make-up ponds is applied to the road daily to provide dust control. Periodic road maintenance and repair is conducted to ensure safe travel and proper drainage.

No new disturbances outside of the ROW are anticipated. Periodic road repairs and maintenance would be conducted as needed. Road maintenance requirements may decrease slightly if power generation is reduced in the future and there is less truck traffic to the ash disposal site.

Transmission, Substation, and Communication System Access Roads

Current and Planned Operations through 2019

As noted above, the Navajo Nation Lease provides NGS Participants use of access roads outside of leased lands for ingress and egress to NGS Project facilities on the Navajo Nation. The existing easements for the transmission line ROW provided for access to transmission system ROWs[14]. In addition, existing public roads, and other federal, state, county, local, and private roads are used to access NGS Project facilities and ROWs. Access roads to the transmission system facilities and power line corridors are generally unpaved. Since original construction (early 1970s), the alignment of the access road network has stabilized, and work, when needed, is generally confined to maintenance within the existing footprint. Infrequently and on an as-needed basis, APS conducts road repair and minor maintenance of access roads to provide safe and reasonable access to the ROW. On the WTS, NVE regularly maintains (grades) the primary access road where needed, and uses but does not maintain the secondary access roads (see maps submitted to Reclamation under separate cover). Currently, if repairs or maintenance is necessary on access road the work is coordinated with the appropriate land management agency. As may be

[13] Ash Disposal Road is referenced as "Road between Plant Site and Ash Disposal" in the lease between SRP and the Navajo Nation.
[14] See existing Transmission line ROW easements and renewal applications.

required by the land management agency, federally listed species and archeology surveys may be conducted. If access roads do not exist due to terrain constraints, maintenance crews use foot access or helicopters to access the transmission line ROWs.

Transmission, Substation, and Communication System Access Roads — Ongoing and Planned Operations Past 2019

The prior right-of-way easements and renewal applications provide for access to transmission system ROWs. In coordination with land managers, APS and NVE would conduct periodic maintenance as needed on access roads to provide reasonable and safe access to transmission system facilities, right-of-way corridors, and towers through 2044. There are no plans for new roads. Transmission line operators would continue to coordinate maintenance activities with the land management agencies as required by easement stipulations, and implement the BMPs described in **Appendix E**. If access roads do not exist due to terrain constraints, maintenance crews use foot access or helicopters to access the transmission line ROWs.

ENVIRONMENTAL COMPLIANCE

Current Operations

NGS is subject to multiple environmental compliance regulations for air, water, and waste. **Table 12** provides a summary of ongoing applicable environmental regulations.

Air Quality Monitoring

The Glen Canyon ambient air monitoring site is 2.7 miles west of downtown Page, Arizona and about 6 miles west of NGS (**Figure 32**). The site was established in October 1983 and has operated continuously, first in accordance with the Arizona Department of Environmental Quality (ADEQ) Operating Permit and then under a FIP issued by EPA. As a requirement of the FIP finalized in 2010, NGS installed, operates, and maintains ambient monitors at Glen Canyon Dam for particulate matter ($PM_{2.5}$ and PM_{10}), NO_2, SO_2, and ozone[15]. A report on data collection

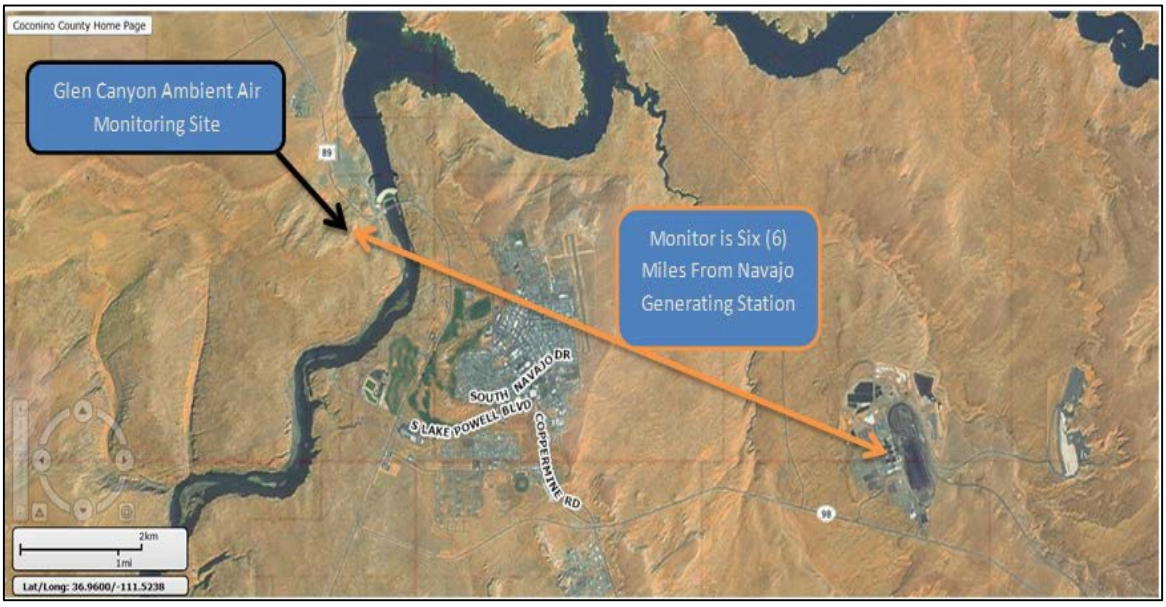
[15] In July 2015, SRP identified an error in the manner in which the 8-hour ozone NAAQS were calculated and reported to EPA. Upon further investigation, including a third-party independent audit, it was determined that the reported ozone concentrations had significant high bias and the NO2 monitor experienced quality control issues. The findings were reported to EPA (Letter and email to Colleen McKaughan, dated July 8 and July 9, 2015, respectively). SRP is completing a comprehensive investigation to determine the causes of the incorrect readings and calculations, and will implement all necessary procedures and actions to assure future data integrity. Based on the audit results and ongoing investigations, SRP recommended to Reclamation that the ozone and NO_2 values recorded at Glen Canyon should not be used for environmental impact statement modeling or assessments. The SO_2,

and monitoring is submitted annually to the Region 9 EPA regional administrators and Navajo Nation EPA.

NGS maintains a quality assurance program to validate data and ensure data integrity and traceability to known standards. The program includes data validation procedures, preventive maintenance, personnel training, chain-of-custody procedures, gas cylinder standards, equipment checks, and program review.

NGS would continue to comply with applicable existing and new environmental compliance regulations for air, water, hazardous material, and other parameters in the future. These activities include the operation of emission controls and necessary monitoring and reporting requirements to ensure compliance with standards and guidelines and taking corrective actions as needed.

Figure 32 - Navajo Generating Station Glen Canyon Air Monitoring Site.



PM_{10}, and $PM_{2.5}$ data from Glen Canyon were unaffected by the findings.

Table 12 - Environmental Regulations Requiring Compliance at NGS.

Regulation / Permit	Regulatory Agency	Constituent Regulated	Reporting Requirements	Retirement Actions
Air				
Clean Air Act, Title V Operating Permit (NNEPA)	NNEPA/EPA	Air emissions National Ambient Air Quality Standard (NAAQS)	Quarterly Excess Emissions to EPA and NNEPA; Semiannual Compliance Certifications and Monitoring reports to NNEPA (copy EPA); Annual Emissions Inventory to NNEPA (copy EPA)	1. Continue data collection and reporting up to shutdown date. 2. Notify NNEPA/EPA when shutdown date is finalized and discuss permit closure procedures, final reporting period (including final Emissions Inventory Questionnaire).
Clean Air Act, Title IV, Acid Rain Permit (incorporated into Title V Permit)	NNEPA/EPA	NOx discharge limitations	Quarterly EDR reporting to EPA	1. Continue data collection and reporting until permit is closed. 2. Notify NNEPA/EPA when shutdown date is finalized and discuss permit closure procedures. 3. Notify Energy Information Administration (EIA) when shutdown date is finalized and discuss final reporting procedures.
Greenhouse Gas (GHG) Reporting Program	EPA	Carbon dioxide and other GHG emissions	Annual report to EPA submitted to EPA by March 31 for previous year	1. Continue data collection and reporting through retirement. 2. Notify NNEPA/EPA when shutdown date is finalized and discuss final reporting procedures
Clean Air Act, prevention of Significant Deterioration Permit (incorporated into Title V Permit)	EPA	Carbon monoxide (30-day and 12 month rolling averages, NOx (30-day rolling average), visible emissions from PAC silos, vehicle miles traveled associated with CaBr2 and PAC chemical deliveries	Maintain records and notify EPA within 2 working days following the discovery of any failure in air pollution equipment which results in excess emissions. Quarterly reporting of any excess emissions and semi-annual reporting of any permit deviations.	1. Continue data collection and reporting until PSD permit is closed. 2. Notify NNEPA/EPA when shutdown date is finalized and discuss permit closure procedures.
Clean Air Act, Federal Implementation Plan (FIP) for NGS - Best Available Retrofit Technology(BART) and the Regional Haze Rule (RHR)	EPA	NOx	1. By December 1, 2019, notify EPA of applicable alternative (A1, A2, A3, or B) (i.e., TWG alternative). 2. Submit annual report summarizing heat input and annual and cumulative emissions of NOx. 3. Make annual report publicly available on website. 4. Submit application to revise Title V Permit by December 31, 2020.	1. Continue data collection and reporting until Title V permit is closed. 2. Notify EPA when shutdown date is finalized and that TWG alternatives and Title V revision will not be implemented.

Regulation / Permit	Regulatory Agency	Constituent Regulated	Reporting Requirements	Retirement Actions
Clean Air Act, Mercury and Air Toxic Standards (MATS) controls (request submitted to incorporate into Title V Permit)	NNEPA/EPA	Hazardous air pollutants: mercury, non-mercury metallic toxics, acid gases, and organic air toxics in addition to boiler tune-ups.	Semiannual compliance reports submitted to NNEPA (copy EPA).	1. Continue data collection and reporting until Title V permit is closed. 2. Notify EPA when shutdown date is finalized and that TWG alternatives and Title V revision will not be implemented.
Clean Air Act, National Emissions Standards for Hazardous Air Pollutants (NESHAP)	NNEPA See also section on Asbestos landfill in *Hazardous and Solid Waste*	Asbestos	1. EPA Region 9 notifications for scheduled O&M activities that exceed threshold amounts. 2. EPA Region 9 annual notifications to for non-scheduled operations, routine maintenance and repairs. 3. EPA region 9 notifications for demolition activities.	1. Contractors must develop abatement and waste management plans before demolition. 2. Submit notification to NNEPA 10 days prior to demolition/renovation activities; include quantity of asbestos to be abated. 3. Follow applicable abatement and air monitoring regulations.
Federal Implementation Plan, Dust Control Plan (incorporated into Title V Permit)	NNEPA/EPA	Fugitive dust	No reporting required.	1. Notify NNEPA/EPA when shutdown date is finalized and discuss permit closure procedures.
Water				
Safe Drinking Water Act Regulations (SDWA)	EPA	On-site potable water	Total Coliform - monthly report submitted to EPA; Total Organic Carbon – Quarterly reporting; Disinfection By Products and Nitrate – annual reporting ; VOCs, Pesticide and SOCx – every 3 years Sanitary Survey conducted once every 3 years (at minimum), last survey conducted January 7, 2016.	1. Perform EPA Sanitary Survey January 2019. 2. Continue data collection and reporting until potable water system is decommissioned; this system will be necessary at least during asbestos abatement. 3. Notify EPA when shutdown date is finalized.
National Pollution Discharge Elimination System (NPDES) Permit	EPA	Industrial waste discharges	NPDES permit is not required because NGS operates a zero liquid waste discharge system.	Reclamation of existing wastewater ponds may be subject to construction permit for stormwater discharges.
Multi-Sector General and Construction Permit for Stormwater Discharges	EPA	Stormwater discharges	Quarterly Discharge Monitoring Reports submitted to EPA. Annual report sent to EPA. MSGP issued for the period June 4, 2015 to June 4, 2020.	1. Continue data collection and reporting up to shutdown. 2. Notify EPA when shutdown date is finalized. 3. Contractors must submit notices of intent (NOIs) to obtain temporary construction general permits (CGPs) for demolition phase 4. After contractor CGPs are in place, the site stormwater permits can be allowed to expire.

Regulation / Permit	Regulatory Agency	Constituent Regulated	Reporting Requirements	Retirement Actions
316(b) Cooling Water Intake Structure Final Rule	EPA	Impingement & entrainment of aquatic life	If required: 40 CFR 122.21(r) reports 2-8: 2 - Source water physical data 3 - Cooling water intake structure data 4 - Source water baseline biological characterization 5 - Cooling water system data 6 - Chosen method of compliance with impingement mortality standard 7 - Entrainment performance studies 8 - Operational Status	1. Notify EPA when shutdown date is finalized; emphasize that NGS uses mechanical draft cooling towers, which are the best technology available (BTA) for reducing impingement and entrainment.
Clean Water Act, Spill Prevention Control and Countermeasure Plan (SPCCP)	EPA	Obtain permits for work affecting waters of the U.S.; Discharges of oil.	Discharge notification if discharge to Waters of the U.S. occurs sent to EPA	1. Update SPCCP in April 2018. 2. Update SPCCP within 6 months of changes (i.e., tank removal) during retirement. 3. Maintain SPCCP until the total oil storage capacity is < 1320 gallons. 4. Contractor must perform periodic inspections and respond to emergencies while in control of the site.
Dam permit ADWR	Dam permit ADWR	Dam north of 60-series ponds	Annual settlement surveys are submitted to ADWR.	1. Submit application to ADWR to remove dam in summer 2017. ADWR has 120 day review period. 2. Respond to ADWR comments within 60 days of receiving initial review. 3. ADWR will complete final design review with 60 days of receiving comments.
Voluntary measure consistent with Arizona Department of Environmental Quality Aquifer Protection Permit and federal requirements of 40 CFR Part 257.	NA	Metals: arsenic barium, cadmium, chromium, fluoride, lead, selenium. Sulfate, total dissolved solids. Oil, grease, total petroleum hydrocarbons, volatile and semi-volatile organic compounds.	No permit required. Ongoing inspections, monitoring, and annual internal reporting. These measures are designed to protect water quality in the regional N-Aquifer. NGS will conduct closure and post closure activities according to GWPP	Implementation of Ground Water Protection Plan (GWPP), including development of a closure plan for ponds and landfills. Implementation of Perched Water Dewatering Work Plan.
Hazardous and Solid Waste				
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Emergency Planning and Community Right to Know Act Regulations	EPA	Reporting hazardous chemical releases and spills. Reporting the amount of hazardous chemicals stored onsite. Reporting annual toxic releases.	Annual Toxic Release Inventory (TRI) Report submitted to EPA by July 1st. Annual Tier II report.	1. Continue data collection and reporting through Retirement. 2. Notify EPA when shutdown date is finalized. 3. Determine data collection and reporting requirements for handoff to Navajo Nation after demolition is complete.

Regulation / Permit	Regulatory Agency	Constituent Regulated	Reporting Requirements	Retirement Actions
Asbestos Landfill Permit	EPA	Asbestos	Current asbestos landfill permitted by EPA in 1993. Records subject to compliance monitoring by the EPA.	Notify the Administrator in writing at least 45 days prior to excavating or otherwise disturbing any asbestos containing waste material that has been deposited at a waste disposal site under this section, and follow the procedures specified in the notification. As necessary, obtain approval of alternate closure and control methods from the Administrator pursuant to 40 CFR §61.151.
Resource Conservation and Recovery Act (RCRA) Regulations	EPA	Solid waste, hazardous waste, universal waste, and used oil.	1. Continue data collection (quantities removed, shipping manifests, etc.) through 2019. 2. Continue to monitor generator status through 2019.	1. Continue data collection (quantities removed, shipping manifests, etc.) through retirement. 2. Continue to monitor generator status through retirement. 3. Notify EPA when shutdown date is finalized. Close solid landfill pursuant to Extension Lease, GWPP, and O&M Plan (See Solid Waste Landfill section) specifications. Monitor pursuant to GWPP and Extension Lease. Construction of new solid waste landfill would not require a Navajo Nation (or EPA) permit, however, Navajo construction specifications would follow the specifications in the Retirement Guidelines and industry standards (e.g.., installation of liners and leachate recovery systems).
Toxic Substance and Control Act Regulations	EPA	Use and disposal of polychlorinated biphenyls (PCB). Chemical data reporting.	1. Annual report (for Internal documentation only) 2. PCB 30-day cleanup notification and certification	1. Continue data collection and internal reporting through retirement. 2. Collect PCB characterization samples according to 40 CFR 761.283. 3. Submit PCB cleanup notification and certification at least 30 days prior to cleanup according to 40 CFR 761.61; follow and document PCB disposal and verification testing procedures from same section.
Occupational Safety and Health Administration (OSHA) Regulations	NA	Multiple industry standards for electric power generation, transmission, and distribution	OSHA Form 300A submitted annually.	1. Applicable throughout retirement activities.

Regulation / Permit	Regulatory Agency	Constituent Regulated	Reporting Requirements	Retirement Actions
Department of Transportation (DOT) Regulations	DOT	Shipment of hazardous waste	3-year document retention for manifests	1. Continue manifest retention through retirement
Resource Conservation and Recovery Act (Subtitle D), Coal Combustion Residuals (CCR)	EPA USEPA published final CCR Rule on April 17, 2015.	Coal Combustion Residuals-Fly ash, bottom ash, FGD scrubber by-product	Extensive reporting requirements from weekly to annually for operations, groundwater monitoring and corrective actions, and closure, and post closure care. All compliance reports will go to the EPA and NNEPA, and will be posted on a publically accessible website. Certified annual fugitive dust plan.	1. Prepare a Landfill Closure Plan per Section 257.102 of CCR Rule and implement other requirements as stated in *Navajo Generating Station: Coal Combustion Residuals Ash Disposal Landfill Requirements (Appendix B of Navajo Project Operation and Maintenance Plan).* 2. Continue data collection and reporting through retirement. 3. Notify EPA when shutdown date is finalized. 4. Determine data collection and reporting requirements after landfill closure is complete.
U.S. Department of Energy Regulations	USDOE	Submit annual reports on status of operations and environmental equipment	EIA Report submitted to DOE	1. Continue data collection and reporting up to shutdown date. 2. Notify USDOE when shutdown date is finalized.
Federal Aviation Administration Obstruction Lighting Requirements	FAA	Lighting used on stacks and facilities more than 200 feet tall.	Notify FAA regarding stack lighting OOS.	1. Notify FAA when stacks are removed.
NRC general license under 10 CFR 31.5	NRC	Radioactive byproduct material - Density / level gauges	1. Perform leak test every 6 months and maintain records. 2. Appoint an individual responsible for compliance and reporting.	1. Continue data collection and reporting up to shutdown date. 2. Notify NRC when shutdown date is finalized. 3. Create a plan to transfer or dispose of byproduct materials according to 10 CFR 31.5; transfer or disposal must be completed within 2 years of shutdown; report all transfers and disposals to NRC.

HEALTH AND SAFETY

Current and Planned Operations through 2019

NGS currently works to maintain a safe and healthy environment for employees and visitors in accordance with Occupational Health and Safety Administration (OSHA) regulations. The NGS Safety Leadership Manual is used to identify the key safety processes in place at NGS to create and maintain a safe workplace. Safety is the shared responsibility of management, employees and the International Brotherhood of Electrical Workers. The NGS Emergency Response Plan (ERP) provides guidelines to ensure the health and safety of NGS employees and the surrounding communities in the event of an emergency, such as fire, explosion, hazardous material release, terrorism, workplace violence, attack, or other catastrophic event (NGS 2012). The ERP includes the guidelines and or links for the coordination of internal and external emergency response processes. The ERP applies to the NGS plant site and associated facilities including the lake pump station and the railroad ROW. The ERP was developed to comply with OSHA regulations.

The primary mission of the ERP is to:

- Ensure the safety of all personnel in the event of an emergency
- Provide response plans and processes that are effective and safe
- Trigger the appropriate response teams as needed
- Provide effective emergency notification to plant personnel
- Secure plant equipment to prevent creating additional employee risks
- Maintain plant operations as applicable

Pre-emergency plans have been developed for primary areas of the plant. The plant has unwritten mutual aid agreements with the City of Page, Peabody Coal, National Park Service, Coconino County Sheriff's Department, and Navajo Nation Police. Local fire and hazardous materials (HAZMAT) teams have been provided copies of the ERP.

The ERP covers a range of emergency incidents including:

- Fire
- Hazardous substance releases
- Medical emergencies
- Confined space or high-angle rescue
- Railroad coal spills

- Workplace violence
- Weapons of mass destruction and bio-terrorism
- Suspicious activity on or near NGS facility or railroad ROW
- Bomb threats

In addition, NGS maintains an emergency action plan (EAP) in accordance with OSHA standards. The purpose of an EAP is to facilitate and organize employer and employee actions during workplace emergencies. The EAP includes, but is not limited to the following elements:

- Means of reporting fires and other emergencies
- Evacuation procedures and emergency escape route assignments
- Procedures to be followed by employees who remain to operate critical plant operations before they evacuate
- Procedures to account for all employees after an emergency evacuation has been completed
- Rescue and medical duties for those employees who are to perform them
- Names or job titles of persons who can be contacted for further information or explanation of duties under the plan

NGS would continue to maintain a safe and healthy environment for all staff, contractors, and visitors in the future. Health and safety procedures and the ERP and EAP would be updated and modified as needed. NGS operations would comply with all applicable regulatory health and safety requirements.

REFERENCES

Arizona Public Service, 2008a. APS Power Line Corridor Management Plan for Vegetation Management 500-2 Navajo to Westwing Power Line. Submitted to Bureau of Land Management.

_____, 2008b. APS Power Line Corridor Management Plan for Vegetation Management 500-2 Navajo to Westwing Power Line. Submitted to Kaibab National Forest, Williams Ranger District.

_____, 2008c. APS Power Line Corridor Management Plan for Vegetation Management 500-2 Navajo to Westwing Power Line. Prepared for Arizona State Land Department.

_____. 2011. Herbicide Corridor Management Plan & Biological Assessment and Evaluation for Transmission Herbicide Project on the Navajo Nation and Big Boquillas Ranch. Submitted to Navajo Nation Forestry Department.

Avian Power Line Interaction Committee (APLIC). 2006. *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006*. Edison Electric Institute, APLIC, and the California Energy Commission. Washington, D.C. and Sacramento, CA.

Brightwell, L. 2013. SRP Power Accounting. Personal communication. September 18.

EPA (Environmental Protection Agency), Air Division. 2008. Acid Rain Permit No. NN 07-01 issued to Salt River Project Agricultural Improvement and Power District, Navajo Generating Station, Page, AZ. May 15.

_____, Air Division. 2012a. Amendment to Prevention of Significant Deterioration (PSD) Permit for the Navajo Generating Station (NGS) – Final Carbon Monoxide (CO) Emissions Limitations Determination. Letter from Deborah Jordon, Director Air Division, EPA to Kara Montalvo, Salt River Project. February 8.

_____, Air Division. 2012b. Prevention of Significant Deterioration Permit Number AZ 08-01A issued to the Salt River Project Agricultural and Power District for the Navajo Generating Station. February 6.

_____, Air Division. 2013a. Available at: http://www.epa.gov/mats/pdfs/20111221MATSsummaryfs.pdf. Last accessed: September 30.

_____, Air Division. 2013b. Supplemental Proposal, Best Available Retrofit Technology (BART) for Navajo Generating Station, Navajo Nation. U.S. EPA Fact Sheet. September 25.

NGS (Navajo Generating Station). 2012. Emergency Response Plan. October 30.

NPS (National Park Service). 2007. A water intake project for the Navajo Generating Station Environmental Assessment/Assessment of Effect. June 2007.

OSMRE (Office of Surface Mining Reclamation and Enforcement), 2014. Four Corners Power Plant and Navajo Mine Energy Project. Draft Environmental Impact Statement. Volume 1. March 2014.

Peterson, R.B. undated. Zero Liquid Discharge – History and Considerations at the Navajo Generating Station. Salt River Project.

SRP (Salt River Project). 2010a. Dust Control Plan for Navajo Generating Station. Pursuant to the Source-Specific Federal Implementation Plan. June 4.

_____. 2010b. Electrical Service Agreement between Navajo Tribal Utility Authority and Salt River Project Agricultural Improvement and Power District. January 1.

_____. 2013. Spill Prevention, Control and Countermeasure Plan. Navajo Generating Station. April.

_____. 2015. Navajo Generating Station Operations, 2019 - 2044. Technical Support Document for NGS-KMC Project, Revision 1. Submitted to Reclamation on May 11, 2015.

U.S. Fish and Wildlife Service. 2008. Biological Opinion for Phase II Utility Maintenance in Utility Corridors on Arizona Forests. July 17.

U.S. Forest Service. 2008. Biological Assessment for Threatened and Endangered Species, Phase II Maintenance in Utility Corridors on Arizona Forests. Apache-Sitgreaves, Coconino, Kaibab, Prescott, & Tonto National Forests, Arizona, Southwestern Region, USDA Forest Service. February 29.

APPENDIX A

NAVAJO PROJECT ASSETS AND FACILITIES ON NAVAJO RESERVATION

Navajo Project Facilities on Navajo Reservation

NGS Facility	Acres	Miles
Plant Site (excluding 500kV yard)	964.82	
Ash Disposal Area	764.87	
Road between Plant Site and Ash Disposal	30.19	
Lake Pump Station	4.47	
Road between Pump Station and N22B	3.13	
Piping and Road between Plant and Lake	40.06	**3.005**
Pump Power Line to Lake Pump	9.06	2.992
Coal Conveyor from Mine to Loading Station	66.32	5.472
Coal Loading Station near the Mine	99.88	
Railroad Path	1,520.47	77.374
230kV Tie Line	1.02	0.044
Preston Mesa Communication site	0.22	
Zilnez Mesa Communication Site	2.37	
Jack’s Peak Communication Site	0.26	
NGS 500kV Switchyard	30.89	
Shared Path from 500 kV yard to edge of plant site	25	
Western Transmission System	41.25	1.700
Southern Transmission System	3,862.05	101.345

APPENDIX B

NAVAJO GENERATING STATION:

COAL COMBUSTION RESIDUALS ASH DISPOSAL LANDFILL REQUIREMENTS

Salt River Project

Navajo Generating Station: Coal Combustion Residuals Ash Disposal Landfill Requirements

July 5, 2017 Revision

1. Background

The U.S. Environmental Protection Agency (EPA) issued a final rule on April 17, 2015 to regulate Coal Combustion Residuals (CCRs) under Subtitle D of the Resource Conservation and Recovery Act (RCRA), 40 CFR Part 257. The CCR rule had an effective date of October 19, 2015 and the rule regulates CCRs at electric utilities. CCRs include fly ash, bottom ash, boiler slag, and flue gas desulfurization materials (FGD). Salt River Project (SRP) operates the Navajo Generating Station (NGS) located near Page, Arizona on the Navajo Nation. The only CCR unit regulated at this facility under the rule is the Ash Disposal Landfill.

The final rule contains key milestones for implementation and requires NGS to provide demonstration of compliance with the requirements, including posting documents to an operating record, publicly accessible internet site, and notifications to the Navajo Nation.

The final rule establishes self-implementing requirements, primarily performance standards that owners or operators of regulated units can implement without any interaction with regulatory officials. Additionally, the EPA enhanced the protectiveness of the standard by requiring certified demonstrations by a qualified professional engineer (QPE) to provide verification that the regulatory requirements were being adhered to. Although the EPA cannot enforce these requirements, citizens may bring an action to enforce the requirements of this rule under RCRA's citizen suit authority. The EPA believes that the recordkeeping and notification requirements will minimize the danger of owners or operators abusing the self-implementing system established in this rule through increased transparency and by facilitating the citizen suit enforcement provisions applicable to the rule.

As implementation of this rule is affected by litigation or EPA guidance, NGS will adjust its compliance strategy accordingly.

2. CCR Management Unit Description - Ash Disposal Landfill

The Ash Disposal Landfill is located approximately one mile east of the plant site and is constructed on native soils with an approximate disposal capacity of 38 million cubic yards. The total disposal site area boundary is 765 acres, with the current planned landfill footprint encompassing approximately 400 acres. The Ash Disposal Landfill was constructed in the early 1970s against the western edge of a mesa outcrop in the Page/Navajo Sandstone Formation. The base of the landfill is sandstone bedrock. The original layers of fly ash and bottom ash were placed as engineered fill that borings indicate have the strength of lean concrete.

Fly ash, bottom ash, and FGD material from the plant that are not beneficially used or sold are hauled to the landfill for disposal. The landfill has terraced embankments which are constructed in 15-foot vertical lifts. CCRs are placed in the horizontal terraces against the vertical sandstone outcrop. To contain storm

water run-off within the ash disposal area, small terraced fills were constructed along the western edge of the embankment

3. CCR Compliance Elements for the Ash Disposal Landfill

3.1 LOCATION RESTRICTIONS- UNSTABLE AREAS CERTIFICATION DEMONSTRATION (257.64)

NGS will provide a certified demonstration by a QPE that the Ash Disposal Landfill is not located in an unstable area, or that engineering measures have been incorporated into the design to ensure that the structural integrity of the facility will not be disrupted if located in an unstable area per three criteria outlined in the rule. This document will be posted to the operating record and public website by October 17, 2018, along with a courtesy notification to the Navajo Nation. While SRP does not believe the Navajo Nation is "the appropriate legal authority" under the Rule in light of the covenant not to regulate contained in the plant lease, NGS will provide the Nation with courtesy notifications as required by the EPA.

3.2 OPERATING CRITERIA

1. Air Criteria (257.80) –A QPE prepared and certified an initial Fugitive Dust Control Plan for NGS before the October 19, 2015 deadline. NGS continues to conduct the necessary dust control activities as described by the Plan. The written plan will be amended and certified by a QPE whenever there is a change in conditions that would substantially affect the written plan. The current plan was posted to the operating record and public website, along with the courtesy notification to the Navajo Nation of the posting before the October 19, 2015 deadline. Subsequent amendments will be posted to the operating record and public website, along with a courtesy notification to the Navajo Nation of the posting.

2. Annual Fugitive Dust Control Report (257.80) – NGS prepared an annual Fugitive Dust Control Report that describes actions taken to control CCR fugitive dust, a record of any citizen complaints, and any corrective measures taken. The first annual report was posted to the operating record and public website no later than 14 months after placing the initial CCR fugitive dust control plan in the facility's operating record. The deadline for completing subsequent reports is one year after the date of completing the previous report. All reports are posted to the operating record and public website, along with a courtesy notification to the Navajo Nation.

3. Run-on/Run-off Controls (257.81) - NGS designed, constructed, is currently operating and maintaining a run-on control system to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm, and a run-off control system from the active portion of the CCR unit that collects and controls at least the water volume resulting from a 24-hour, 25-year storm. The run-off from the active portion of the CCR unit is handled in

accordance with the surface water requirements under 257.3-3. The initial run-on and run-off control system plan was developed before the October 17, 2016 deadline and contains the required elements in the CCR rule 257.81 including the required QPE certification. The initial plan was posted to the operating record and public website along with a courtesy notification to the Navajo Nation.

NGS may amend the written plan at any time provided the revised plan is placed in the facility's operating record. NGS must amend the plan whenever there is a change in the conditions that would substantially affect the written plan in effect. Revision of the plan must be completed every five (5) years. The amended plan requires a QPE certification stating the plan meets the requirements of 257.81. Subsequent renewals will be posted to the operating record and public website along with a courtesy notification to the Navajo Nation.

4. Landfill Seven-Day Inspections (257.84) – A qualified person began conducting inspections every seven (7) days before October 19, 2015. The qualified person inspects the landfill for actual or potential structural weaknesses and other conditions that are disrupting or have potential to disrupt operations or safety of a CCR unit. Documented inspection results are being posted to the operating record.

5. Annual Landfill Inspection and Report (257.84) – NGS retained a QPE to complete an initial annual inspection of the landfill prior to January 19, 2016. The first subsequent annual inspection was conducted within one year as required by the rule. The inspections and certifications by the QPE reports ensure the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally-excepted good engineering standards. The inspections and reports contain minimum elements as outlined in 257.84.

If a deficiency or release is identified during an inspection, the deficiency or release is remedied as soon as feasible and a document detailing the corrective measures is prepared.

NGS posted the initial and first subsequent annual landfill inspection and deficiency corrective measures reports to operating record and public website, the Navajo Nation was provided a courtesy notification of the posting. Future annual reports will meet the requirements of 257.84.

3.3 GROUNDWATER MONITORING AND CORRECTIVE ACTION

1. Annual Groundwater Monitoring and Corrective Action Report (257.90) – NGS will prepare the first annual groundwater monitoring and corrective action report by January 31, 2018. Subsequent annual reports must be prepared by January 31st each year for the prior year. At a minimum, the report must contain the required information outlined in 257.90. Reports will be posted to the operating record and public website, along with a courtesy notification to the Navajo Nation.

2. Groundwater Monitoring Systems, Sampling and Analysis–NGS will prepare and conduct the following work by October 17, 2017 as required by 257.90, 257.91, 257.93, and 257.94:

- Install a groundwater monitoring system well network.
- Develop a groundwater Sampling & Analysis Plan (SAP).
- Develop a QPE-certified Statistical Data Analysis Plan.
- Groundwater elevations must be measured in each well immediately prior to purging, each time the groundwater is sampled.
- Conduct a minimum of eight (8) independent samples from each background and down gradient well.
- Analyze the eight rounds of samples for the constituents in CCR rule Appendix III and IV.
- Evaluate the first set of groundwater detection monitoring data for statistically significant increases (SSI) over background levels for the constituents listed in Appendix III.
- If groundwater elevations indicate the groundwater direction shifts over time, adjustments in the groundwater monitoring system well network may be necessary.

NGS will post the groundwater monitoring system certification and Statistical Data Analysis Plan to the operating record and public website, along with a courtesy notification to the Navajo Nation. All monitoring data will be included in the annual groundwater monitoring and corrective action report.

3. Groundwater monitoring system documentation (257.91)- NGS will document and include in the operating record the design, installation, development, and decommissioning of monitoring wells, sampling, and analytical devices by October 17, 2017. The QPE will be given access to this documentation when completing the groundwater monitoring system certification. Monitoring wells, sampling, and analytical devices will be operated and maintained so that they perform to the design specifications throughout the life of the monitoring program.

4. Groundwater monitoring system certification (257.91) - NGS will obtain a certification from a QPE stating the groundwater monitoring system has been designed and constructed to meet the requirements of 257.91 by October 17, 2017. The groundwater monitoring system certification will be posted to the operating record and public website, along with a courtesy notification to the Navajo Nation.

5. Detection monitoring program (257.94) – NGS will conduct semi-annual detection monitoring for the constituents listed in Appendix III and evaluation for SSIs for the active life of the ash landfill and post-closure period. Groundwater data will be published in the annual groundwater monitoring and corrective action report, if required. NGS may demonstrate the need for an alternative monitoring frequency for repeated sampling and analysis for listed Appendix III

constituents during the active life and the post-closure care period per the requirements in CCR rule 257.94.

6. Detection monitoring with a statistically significant increase over background (257.94) - If a SSI occurs over background for any Appendix III constituent, NGS will within 90 days either (1) initiate an assessment monitoring program and provide notice as required, or (2) demonstrate and certify the SSI occurred for a source other than the Ash Disposal Landfill. The SSI determination is published in the annual groundwater monitoring and corrective action report. If no SSI is detected, then continue detection monitoring program semi-annual monitoring.

If the assessment monitoring program is established, NGS will prepare a notification. The notification will be posted to the operating record and public website, and a courtesy notification sent to the Navajo Nation.

7. Assessment monitoring program (257.95) - If triggered by the SSI in detection monitoring, NGS will initiate assessment monitoring within 90 days. Assessment monitoring will include the required elements in 257.95 including sampling and analyzing the groundwater for all constituents listed in Appendix IV of the CCR rule. NGS may demonstrate the need for an alternative monitoring frequency as allowed in 257.95. Assessment monitoring results of Appendix III and IV constituents will be posted, as required under the rule, to the operating record, public website and/or courtesy notification(s) will be sent to the Navajo Nation. One of the following actions will be taken as a result of assessment monitoring:

- If the sample results for Appendix III and IV constituents for two consecutive sampling events are less than or equal to the background, NGS will return to the detection monitoring program.
- If sample results are greater than background and less than the groundwater protection standard (GWPS), assessment monitoring will continue.
- If a SSI occurs over GWPS for any Appendix IV constituent, NGS will provide required notification(s), including appropriate land owners or residents. NGS will characterize the nature and extent of the release and any relevant site conditions that may affect the remedy ultimately selected.

  Within 90 days NGS will either (1) Initiate assessment of corrective measures as required by 257.96, or (2) demonstrate and certify that the exceedance of the GWPS was an error or caused by a source other than the Ash Disposal Landfill.

  - If the exceedance was caused by another source, a QPE-certified demonstration report must be made in compliance with 257.95 and continue with either assessment or detection monitoring under the rule. This certified demonstration report will be included in the annual groundwater monitoring and corrective action report. If a successful demonstration has not been made

at the end of the 90-day period, NGS will initiate the assessment of corrective measures.

- If the SSI is attributed to the CCR Landfill, NGS will initiate the assessment of corrective measures as required by 257.96. Within 30 days of initiating assessment of corrective measures, a notification will posted to the operating record and public website along with a courtesy notification to the Navajo Nation.

8. Assessment of corrective measures (257.96), remedy selection (257.97), corrective action implementation (257.98) – Within 90 days of finding that a SSI has occurred, or immediately upon detection of a release from a CCR unit, NGS will initiate an assessment of corrective measures to prevent further releases, to remediate any releases and to restore affected area to original conditions. NGS will follow all requirements, as required by 257.96, including obtaining a QPE certification that the assessment of corrective measures demonstration is accurate, conducting a public meeting to interested and affected parties, making a record of the public meeting, completing a QPE-certified selected remedy report and semi-annual progress reports, and initiating and completing the remedy. Required documents will be incorporated into the annual groundwater and corrective measures report, operating record, public website and courtesy notification to the Navajo Nation as required by 257.96, 257.97 and 257.98.

3.4 CLOSURE AND POST CLOSURE CARE

1. Landfill Closure Plan (257.102) – NGS prepared and posted a written Landfill Closure Plan, certified by a QPE, before October 17, 2016. The plan will be amended and certified as needed 60 days prior to substantial operational changes, 60 days after unintended changes, or 30 days after changes to current closure activities. The current closure plan meets the requirements of 257.102, future plans will also meet the requirements of 257.102. The Landfill Closure Plan was posted to the operating record and public website along with a courtesy notification to the Navajo Nation.

2. Notice of Intent to Close (257.102) - NGS will prepare a Notice of Intent (NOI) including Final Cover Certification by a QPE to close the Ash Disposal Landfill prior to start of closure activities; closure must commence within 30 days of last receipt or removal for beneficial use. NGS will post the NOI to the operating record and public website and send a courtesy notification to the Navajo Nation of the posting.

3. Time extension demonstration for idle unit (257.102) - If the CCR Landfill unit does not receive CCR material for a period of 30 days, or is no longer removing CCR for the purpose of beneficial use within two years and is expected to continue operation, a demonstration must be made with an owner signed statement, reasons for time extensions for idle units; no more than five (5), two- year extensions are allowed. NGS will post time extension demonstrations to the operating record and public website and a courtesy notice sent to the Navajo Nation.

4. Closure timing and extension demonstration (257.102) - Closure must be completed within six (6) months after commencing closure, unless an extension demonstration is made. No more than two (2), one -year extension demonstrations can be obtained. NGS will post the landfill time extension demonstration to the operating record and public website along with a courtesy notification to the Navajo Nation.

5. Certified closure completion (257.102) - Within 30 days of closure completion, NGS will provide a QPE certified notification of closure completion. The certified closure completion notification will be posted to operating record and public website and a courtesy notice sent to the Navajo Nation.

6. Modified Deed Notation (257.102) - Following closure completion per applicable property law, NGS will record a new deed restriction(s) and make notification that deed notation is recorded. Within 30 days of recording a notation, NGS will post a notification to the operating record and public website and courtesy notice to the Navajo Nation.

7. Notice of Intent - Alternative Closure and Annual Alternative Closure Progress Reports (257.103) - Within six (6) months of a trigger event outlined in 257.101 and if the unit meets the criteria for alternate closure in 257.103, NGS will provide a NOI to comply with alternative closure requirements, including a description of qualifying requirements. NGS will prepare annual progress report(s) during alternative closure to document continued lack of alternative capacity and progress towards development of alternative disposal capacity. If no alternative capacity is identified within five (5) years after the initial certification, the Ash Disposal Landfill must cease receiving CCR and close in accordance with 257.102 timeframes. NGS will post required documents to the operating record, public website and Navajo Nation courtesy notification of the posting(s).

8. Certified Post-Closure Plan (257.104) – NGS will prepare a post- closure plan and obtain a certification by a QPE that the plan meets the CCR rule requirements. NGS will amend and recertify the post-closure plan as needed 60 days prior to a plan change or within 60 days of an unanticipated event. NGS will post the post-closure care plan to the operating record and public website and send the Navajo Nation a courtesy notification of the posting.

9. Certified Post-Closure Care Completion (257.104) – NGS will obtain a certification by a QPE verifying that post-closure care has been completed in accordance with the post-closure plan and 257.104. NGS will post the post-closure care completion report to the operating record and public website and send the Navajo Nation a courtesy notification of the posting.

APPENDIX C

NAVAJO GENERATING STATION:

GROUNDWATER PROTECTION PLAN

Salt River Project

Navajo Generating Station: Groundwater Protection Plan

April 10, 2017 Revision

Document Control Log Record

Navajo Generating Station: Groundwater Protection Plan

Revision Date	Description of Document Modifications	Modified by:	Approved by:
January 30, 2015	Original		
November 9, 2015	Added document control log, removed Section 4.4.3 Inert Material Landfill and Washout Basin, updated Section 4.4.4. (now 4.4.3) Solid Waste Landfill, updated Section 6.2 Table 5 Heavy Equipment Oil Water Separator internal inspection, removed Inert Landfill from Section 6.4 Landfill Inspections Table 7, added Ponds S1 and S2 alert levels Section 9 Table 8, and updated Section 10 emergency contacts.	Andrea Martinez	Paul Ostapuk
April 10, 2017	Addition of List of Tables. Addition of NGS aerial and cross-section figures. Updated Figure 1, Figure 3, Figure 9, Table 1, and Table 3. Inclusion of new equipment/facilities: MW-29, MW-74, HEBS OWS, FD OWS, and Pond SD-5. Addition of subsections describing new OWS characteristics, BADCT, and monitoring. Revisions to OWS inspections with the removal of internal inspections during overhaul. Addition of alert levels for Ponds S-3 and S-13. Removed Tables 10b-10m; added clarification why there are no monitoring thresholds (MTs) for pump back wells; adjusted MTs and contingencies for deep wells; updated MTs and Maximum Contaminant Levels for TDS and sulfate. Adjusted contingency response times. Removed "Boiler Chemical Cleaning Sampling" section.	Karis Nelson	Paul Ostapuk

CONTENTS

TABLE OF FIGURES

LIST OF TABLES

1 FACILITY INFORMATION

Facility Name: Navajo Generation Station (NGS)
Operator: Salt River Project Agricultural Improvement and Power District (SRP)
Mailing Address: P.O. Box 850, Page, AZ 86040
Physical Address: State Highway 98, Five miles east of Page, Arizona
Facility Contact: Paul Ostapuk, NGS Environmental Operations and Maintenance
Contact Telephone Number: 928-645-6577
Emergency Telephone Number: 928-645-7222 or 911
Latitude: 36° 54.283' N **Longitude**: 111° 23.317' W

2 PURPOSE OF GROUNDWATER PROTECTION PLAN

Salt River Project (SRP) is committed to the protection and preservation of natural resources and strives to meet the needs of our customers while protecting the environment through compliance with applicable federal and state statutes and regulations,[1] and implementation of innovative policies, programs, and technologies. In keeping with this commitment, SRP has adopted best management practices at Navajo Generation Station (NGS) to protect the Navajo Sandstone Aquifer ("N Aquifer") and vadose zone[2] from perched water that has accumulated beneath the plant site in the Carmel Formation.

Although there is no imminent risk of contaminating the aquifer, measures are being taken to proactively address the issue— water is being pumped from the Carmel Formation in accordance with the *Perched Water Dewatering Work Plan (*see Appendix 1*)* and the ponds, landfills, oil-water separators, and monitoring wells at NGS are being managed according to the *Groundwater Protection Plan* (described herein). The *Groundwater Protection Plan* was developed to assure compliance with applicable federal and state statutes and regulations governing the management and handling of plant process water and is modeled after the Arizona Department of Environmental Quality (ADEQ) aquifer protection permit (APP) program.[3] The *Groundwater Protection Plan* is reviewed annually and updated as necessary. [4]

[1] Federal and state regulations governing the handling and management of plant process water are listed in SRP 2014 (Navajo Project Description Report; Table 6)
[2] The vadose zone is the unsaturated portion of the earth's subsurface that lies above the groundwater table. The soil and rock in this zone may contain a mixture of air and water in its pores. Unlike the aquifers of the saturated zone (i.e., water-bearing aquifers), the unsaturated zone is not a source of readily available water for consumption.
[3] NGS is not subject to the jurisdiction of ADEQ and the APP because the NGS is located on tribal land. Applicable federal and state regulations are listed in *SRP 2014 Navajo Project Description Report*; Table 6).
[4] In addition to the semi-annual sampling outlined in this *Groundwater Protection Plan* (GWPP), the U.S. Environmental Protection Agency (EPA) issued a final rule on April 17, 2015 (effective October 19, 2015) to regulate Coal Combustion Residuals (CCRs) at electric utilities under Subtitle D of the Resource Conservation and Recovery

3 SITE DESCRIPTION AND BACKGROUND

NGS is a coal-fired, steam electric generating facility located about five miles east of the city of Page in northern Arizona, see Figure 1. The plant site is built on 1,021 acres of tribal land that is leased from the Navajo Nation and began commercial operation in 1974. The NGS Participants include SRP, United States Department of Interior Bureau of Reclamation (DOI), Arizona Public Service Company (APS), Nevada Power Company (NV Energy), and Tucson Electric Power Company (TEP). SRP is the operating agent.

Figure 1: Location Map – Navajo Generating Station East of Page, Arizona

The plant site is currently comprised of three coal-fired units (2,250 MW net), three wet limestone scrubbers, three electrostatic precipitators, 230 and 500kV switchyards, cooling towers, storage ponds and reservoirs, lake pumping station and pipeline, landfills, coal and ash handling facilities, heavy equipment maintenance building, railroad maintenance facilities, machine shop, warehouse, and administration building. Additionally, a separate 765-acre area (one mile east of the plant site) is used for ash disposal. The entire water supply for the plant is pumped approximately four miles from Lake Powell, the man-made reservoir created by Glen Canyon Dam.

Act (RCRA). CCRs include fly ash, bottom ash, boiler slag, and flue gas desulfurization materials (FGD). The CCR monitoring program is a different program than the voluntary GWPP.

NGS was designed as a zero liquid-discharge facility, meaning that water brought onto the plant site would not be released other than in the form of evaporation. Water captured from cooling tower blowdown, storm water run-off from developed areas of the facility, and other plant processes are recovered and recycled through a series of storage ponds and water facilities. Plant process water is treated with brine concentrators and a crystallizer, which reclaims the water for reuse in water circulation systems at the plant. The solid material that accumulates during the treatment process is disposed in double-lined salt disposal cells with leachate recovery systems. In the event that the concentrators or crystallizer are taken out of service, or there are significant discharge or run-off events, a series of impoundments are used to capture and regulate the flow of plant process water or precipitation run-off.

The environmental setting surrounding NGS is quite unique. NGS resides 4,400 feet above sea level in the Colorado Plateau physiographic province, which is characterized by mesas, long escarpments, broad valleys, and deep canyons that have been eroded from flat-lying sedimentary deposits. The geologic units found in the area include:

- **Recent-age Dune Sand**

  The dune sand is deposited as thin discontinuous veneers of red-brown typically unconsolidated sands that can be up to 15 feet thick. The sands are mostly present within the eastern plant site areas and in the ash disposal area. The sands rest on the erosional surface of the Carmel Formation.

- **Jurassic Carmel Formation**

  The relatively thin Carmel Formation (10-70 feet thick) exists beneath the plant site area and rests non-conformably on the Page Sandstone Formation. The formation consists of siltstone, clay stone, and sandstone. The presence of siltstone and clay stone layers significantly reduces vertical permeability of the formation. As such, isolated perched zones of groundwater can occur.

- **Page Sandstone Formation**

  The Page Sandstone is a 100-150 feet thick, cliff-forming, cross-bedded sandstone formation previously considered part of the Navajo Sandstone. In 1978, the United States Geological Survey (USGS) published field work indicating that the Page Sandstone Formation is younger than the Navajo Sandstone Formation. The two formations are separated by a regional

Jurassic erosional surface known as the J-2 unconformity and both are present beneath the entire NGS facility.

- **Navajo Sandstone Formation**

  The Navajo Sandstone Formation is approximately 1,400 feet thick in the NGS facility area. The Navajo Sandstone comprises the regional Navajo Sandstone Aquifer. Groundwater is present under unconfined conditions at a depth of approximately 3,400 to 3,500 feet mean sea level (msl). An estimated 900 feet of unsaturated Page/Navajo Sandstone separates the isolated perched water in the Carmel Formation (beneath the plant site) from the N Aquifer and is illustrated in Figure 2.

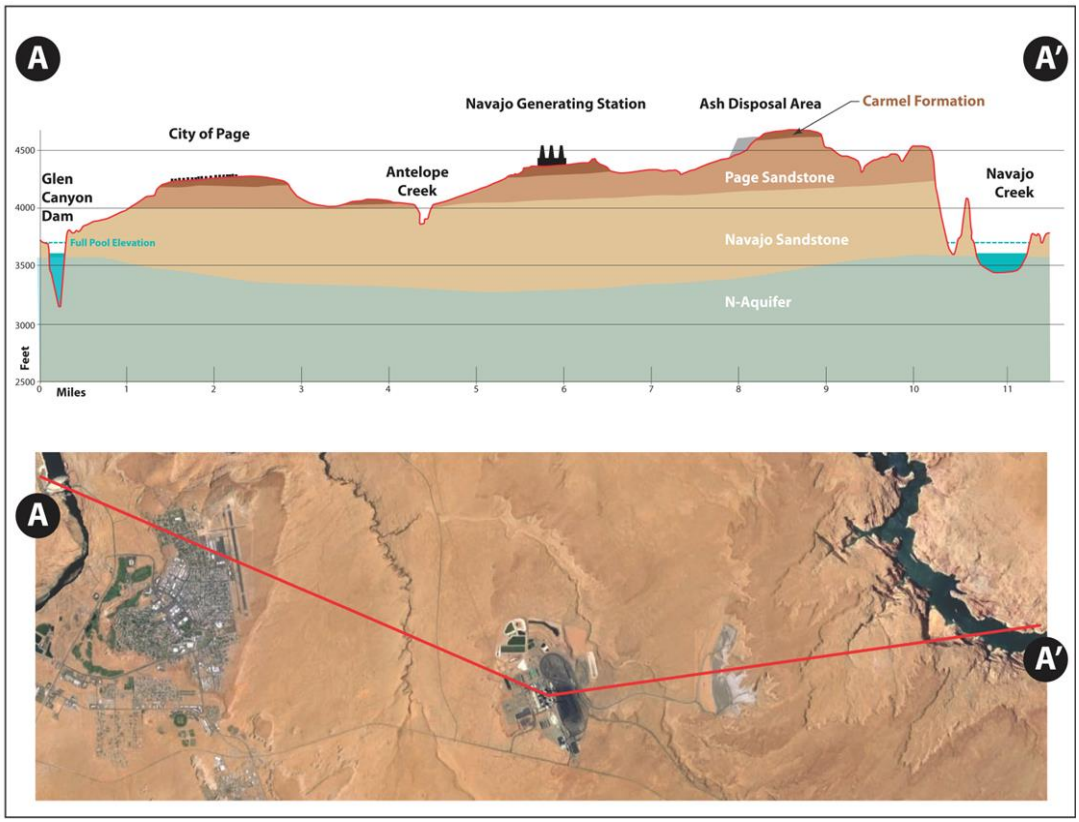


Figure 2: Generalized Geologic Cross Section Surrounding NGS

The ambient quality of groundwater in the N Aquifer has been established from samples collected from monitor wells screened in the Navajo Sandstone Formation. The water quality is considered very good, consisting of calcium bicarbonate type water with relatively low concentrations of total dissolved solids (TDS). The groundwater flow direction is generally toward the southwest. However, the perched water

beneath the plant site contains elevated levels of TDS and certain metals. Sources of the perched water include past seepage from evaporation ponds, unlined drainages ditches, cooling towers, and the ash dewatering area.

Corrective actions have been taken at NGS to address the perched water conditions beneath the plant site. These corrective actions include upgrades to the pond liners, upgrades to linings in the drainage ditches of the ash dewatering area, and repairs to cooling tower basins. Additionally, shallow monitor wells with dedicated positive displacement pumps ("pump back wells") have been installed to control the migration of the perched water.[5] The water extracted from these wells is reclaimed into the plant processes.

The *Navajo Generating Station Groundwater Monitoring Program (1978-Present)* report provides more information on the geohydrology surrounding the plant and a summary of long-term monitoring of the N Aquifer by SRP (see Appendix 2).

4 FACILITIES

The facilities covered in this document include ponds, ditches, oil-water separators, and landfills. For each type of facility, the *Groundwater Protection Plan* describes the pertinent characteristics, Best Available Demonstrated Control Technology (BADCT), and inspection protocols. The description and BADCT described for each facility is based on current conditions and will be maintained as part of the *Groundwater Protection Plan*. Inspection and monitoring of each facility are developed and implemented according to current conditions and best management practices.

4.1 Ponds

The wet ponds at NGS serve as plant process water reservoirs. NGS also uses dry ponds (cells) to store solid waste generated from the crystallizers.[6] The ponds are operated and maintained to prevent liner failure, uncontrollable leakage, overtopping, berm/embankment breaches, or accidental spills. The characteristics and locations of the ponds currently in use at NGS are described in Table 1 and Figure 3.

[5] These pump back wells cycle at rates less than 5 gallons per minute (gpm).
[6] See *SRP 2014 Navajo Project Description Report* (Wastewater Management section) that describes wet and dry pond management.

Table 1: Characteristics of Active Ponds at NGS

Pond ID	Contents	Volume (AC-FT)	Engineering and Monitoring							
			Berm	Lining Types (if lined)					Leachate Collection System	Leak Detection System
				Single 100-mil	Double 60-mil	Double 100-mil	Concrete	Soil Cement		
35-1	Brine concentrator and crystallizer blowdown	20	●	●						
35-2	Brine concentrator and crystallizer blowdown	15	●	●						
35-6	Brine concentrator blowdown, pond overflow	61.7		●						
35-R	Pond overflow	7	●	●						
60-1A	Cooling tower and Pond S-13 blowdown	107.2				●			●	●
60-1B	Cooling tower and Pond S-13 blowdown	125.3				●			●	●
60-2A	Overflow from 60-2C	128	○			●			●	●
60-2B	Overflow from 60-2D	128	○			●			●	●
60-2C	Crystallizer drain sump pump blowdown	16				●			●	●
60-2D	Crystallizer drain sump and Ponds 35-1/35-6 blowdown	17				●			●	●
NE-2	Storm water from engine house and east side of coal pile	41.5	●			●			●	
NE-5	Storm water from engine house and east side of coal pile	12.8	●							
A, B	Softened (make-up) water	11.9	●				●			
S-1	Process water	9.6			●				●	●
S-2	Process water	8.4			●				●	●
S-3	Process water	13			●				●	●
S-13	Storm and process water	30.6	●		●				●	●
SD-3	Dry cell - Crystallizer salts/precipitates	23.2				●			●	
SD-5	Dry cell - Crystallizer salts/precipitates (completion expected mid-2017)	17.4			●				●	●
SR-1	Clarifier sludge	8.7						●		
SR-2	Clarifier sludge	9.8						●		

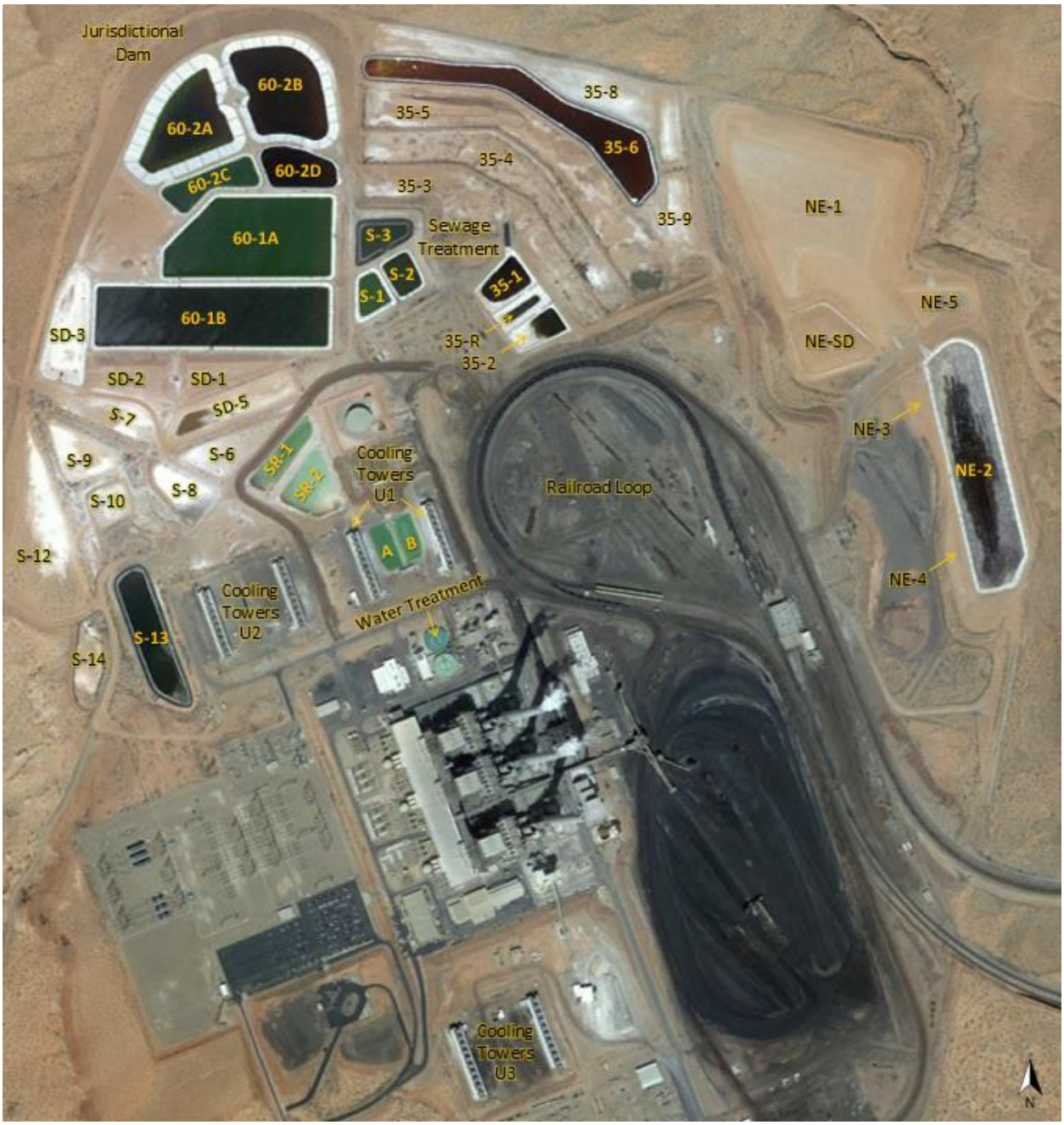


Figure 3: Locations of Active and Exempt Ponds

4.1.1 35-Series Ponds

Ponds 35-1, 35-2, and 35-R were installed in 2008. Ponds 35-1 and 35-2 receive blowdown from brine concentrators #1, #2, and #3 and the crystallizer. These ponds are 20.0 acre-feet (AC-FT) and 15.0 AC-FT in volume, respectively. Pond 35-R receives overflow from Ponds 35-1 and 35-2 and is 7.0 AC-FT in volume. Water is pumped from Pond 35-R to the crystallizer to be processed as needed.

Pond 35-6 was installed in 2009 to allow for the construction of the 60-2 Series ponds by collecting blowdown from the brine concentrators and overflow from other various ponds. The pond also collects water from the French Drains of Ponds 35-1 and 35-2. The pond is 61.7 AC-FT in volume.

4.1.1.1 Best Available Demonstrated Control Technology

Ponds 35-1, 35-2, 35-6, and 35-R are single-lined with 100-millimeter thick high density polyethylene (100-mil HDPE). Ponds 35-1, 35-2, and 35-R are retained by earthen berms and regulated with French Drains, but do not have leachate collection or leak detection systems.

Pond 35-6 is not associated with a berm nor does it have leachate collection or leak detection systems.

4.1.2 60-1-Series Ponds

Ponds 60-1A and 60-1B were installed in 2011 and 2012, respectively. Pond 60-1A is 107.2 AC-FT in volume and Pond 60-1B is 125.3 AC-FT in volume. The ponds receive blowdown from Pond S-13 and cooling towers 1-A, 1-B, 2-A, 2-B, 3-A, and 3-B. Water from these ponds is pumped to the brine concentrators to be treated and recycled for use in the plant.

4.1.2.1 Best Available Demonstrated Control Technology

Ponds 60-1A and 60-1B are double-lined with 100-mil HDPE and are equipped with pumps and double wet wells. Separate under-drain leachate collection systems and separate leak detection systems are used to detect leaks between and beneath the HDPE liners. No berms are associated with Ponds 60-1A and 60-1B.

4.1.3 60-2-Series Ponds

Ponds 60-2A, 60-2B, 60-2C, and 60-2D were installed in 2010 (60-2B, 60-2C, 60-2D) and 2012 (60-2A). Pond 60-2A receives overflow from 60-2C and Pond 60-2B receives overflow from Pond 60-2D. Ponds 60-2C and 60-2D receive blowdown from the Crystallizer drain sump pump when the crystallizer is shut down, although the blowdown is primarily released into Pond 60-2D. Pond 60-2D may also receive inflows from Ponds 35-1 or 35-6 via a portable diesel pump.

Ponds 60-2A and 60-2B are connected through a spillway and each retains a volume of 128.0 AC-FT. The volumes for Ponds 60-2C and 60-2D are 16.0 and 17.0 AC-FT, respectively. In total, the 60-2 Series Ponds have a total surface area of 26.1 acres and a total storage capacity of 289 AC-FT.

4.1.3.1 Best Available Demonstrated Control Technology

Ponds 60-2A, 60-2B, 60-2C, and 60-2D are double-lined with 100-mil HDPE and are equipped with pumps, double wet wells, and share an under-drain leachate collection system. Separate monitoring systems are used to detect leaks between and beneath the liners. No berms are directly associated with these ponds; however, Ponds 60-2A and 60-2B are directly retained by a jurisdictional dam.

4.1.3.2 Pond 60-2A and 60-2B Jurisdictional Dam

Jurisdictional dam (ADWR ID #03-38) is a compacted, engineered earthen dam, approximately 50 feet high, 2700 feet long, and 45 feet wide along the top. The dam is supplemented with berms that help prevent erosion and provide structural support. In the case of a system failure, the dam would retain overflow from the 60-2 series ponds.

4.1.4 NE-Series Ponds

Ponds NE-2 and NE-5 were installed in 2012. The ponds remain dry except in the event of inclement weather and infrequent storm water run-off. Storm water from the east side of the coal pile and from the engine house feeds into Pond NE-2 and can overflow into Pond NE-5 as needed. The volumes of the ponds are 41.5 and 12.8 AC-FT, respectively.

4.1.4.1 Best Available Demonstrated Control Technology

Pond NE-2 is double-lined with 100-mil HDPE and is retained by an earthen berm. The pond is equipped with double wet wells, a drainage pipe, and a leak collection vault. Leakage from the pond can be determined through visual inspection of the vault for the presence of water but no leak detection system is installed. If needed, water can be removed from the vault using a portable pump.

Pond NE-5 is a compacted native earth, unlined pond, which is retained by an earthen berm. There are no leachate collection or leakage detection systems associated with Pond NE-5.

The spillway between Pond NE-2 and Pond NE-5 is made of concrete.

4.1.5 Pond A and Pond B ("Makeup Reservoir")

The Makeup Reservoir was installed north of the water treatment area when the first unit began operation. The reservoir is comprised of two primary storage basins (Pond A and Pond B) and three secondary pumping compartments, and retains softened water at a maximum capacity of 11.9 AC-FT with a freeboard of 1 foot 5 inches. Although the reservoir is 10 feet 0 inches in depth, the ponds will overflow into their respective spillways when the water level reaches 9 feet 6 inches. Overflow from the reservoir flows to the S-13 pond via underground piping. One-million gallons of the water in the reservoir is reserved for fighting fires.

4.1.5.1 Best Available Demonstrated Control Technology

The primary basins of the Makeup Reservoir are formed by dikes and are concrete-lined. Sodium hypochlorite solution is added daily for algae control. This pond is not associated with a berm nor does it have leachate collection or leak detection systems.

4.1.6 S-Series Ponds

Ponds S-1 and S-2 were installed in 1988 and are used to collect processed water from the oil-water separators from each unit. In 2014, the ponds were re-lined and a shared leachate collection system and separate leak detection systems were installed. The ponds are 9.6 and 8.4 AC-FT in volume, respectively.

Pond S-3 was also installed in 1988 but is used to collect effluent from the sewage treatment facility in addition to de-oiled water from Ponds S-1 and S-2. Pond S-3 was re-lined in 2016/2017 and a leachate collection system and leak detection system were installed. Pond S-3 is 13.0 AC-FT in volume.

Pond S-13 was installed in 1989 and predominantly collects storm water from the west side of the power block, but may also receive cooling tower blowdown or overflow from the Makeup Reservoir. Pond S-13 was re-lined in 2015 and a leachate collection system and leak detection system were installed. The pond is 30.6 AC-FT in volume.

4.1.6.1 Best Available Demonstrated Control Technology

Ponds S-1, S-2, S-3, and S-13 are double-lined with 60-mil HDPE and use under-drain leachate collection systems and leak detector pumps. No berms are associated with Ponds S-1, S-2, or S-3 but Pond S-13 is retained by an earthen berm.

4.1.7 SD-Series Dry Ponds

Dry pond SD-3 was installed in 2010 to collect precipitates from the crystallizer. SD-3 retains a volume of 23.2 AC-FT. In anticipation of the closure of SD-3, dry pond SD-5 was converted from retired wet pond (S-5) into a dry storage cell in 2016/2017. Pond SD-5 is expected to retain 17.4 AC-FT once completed.

4.1.7.1 Best Available Demonstrated Control Technology

SD-3 is double-lined with 100-mil HDPE and is monitored using a leachate collection system that returns leachate to Pond 60-1B. No berm is associated with the pond.

SD-5 will be double-lined with 60-mil HDPE and will have leachate collection and leak detection systems upon its completion in mid-2017.

4.1.8 SR-Series Ponds

Ponds SR-1 and SR-2 were installed in 1988. Pond SR-1 is 8.7 AC-FT and Pond SR-1 is 9.8 AC-FT in volume. Both are backup ponds which receive discharge from the Clarifier Softener pump discharge lines when the clarifier softener sludge holding tanks become unavailable.

4.1.8.1 Best Available Demonstrated Control Technology

Ponds SR-1 and SR-2 are unlined ponds with 12 inches of soil cement. These ponds are not associated with a berm nor do they have leachate collection or leak detection systems.

4.1.9 Exempt Ponds

Certain historic ponds at NGS are exempt from the *Groundwater Protection Plan*. Exempt ponds are those that have been taken out of service and may be capped, closed, or covered, and therefore are not subject to the entire suite of inspections. However, inspection of the associated berm, if applicable, remains crucial to the closure of the pond.

Table 2: Retired or Out-of-Service Wet and Dry Ponds

Exempt Ponds	
35-3*	NE-SD* (dry pond)
35-4*	S-6
35-5*	S-7
35-7*	S-8
35-8*	S-9
35-9*	S-10
60-1	S-11
60-2	S-12
NE-1* (dry pond)	S-14*
NE-3	SD-1† (dry pond)
NE-4	SD-2*† (dry pond)

Notes for Table 2:

**A berm is associated with the pond and berm inspections will continue.*

†SD-1 and SD-2 are capped and covered with soil. However, they share a common leachate system that is inspected on a weekly basis or after a rainstorm. Any water captured in the sump is manually pumped to Pond 60-1B.

4.2 Oil-Water Separators

Oil-water separators (OWSs) are installed at NGS to remove oil from plant process water, see Figure 4. Oily water passes through several vaults where the oil is removed through gravity separation (i.e., the specific gravity difference between the oily waste and water). The processed water is discharged from the separator and the oily sludge is retained in the separator to be removed semi-annually or as necessary, depending on the location of the OWS and the findings of the routine monthly inspections. NGS ensures OWS optimal efficiency to make sure recycled water returned to the plant is of good quality. Sludge collected from the OWSs is characterized for proper disposal with EPA rules and regulations.

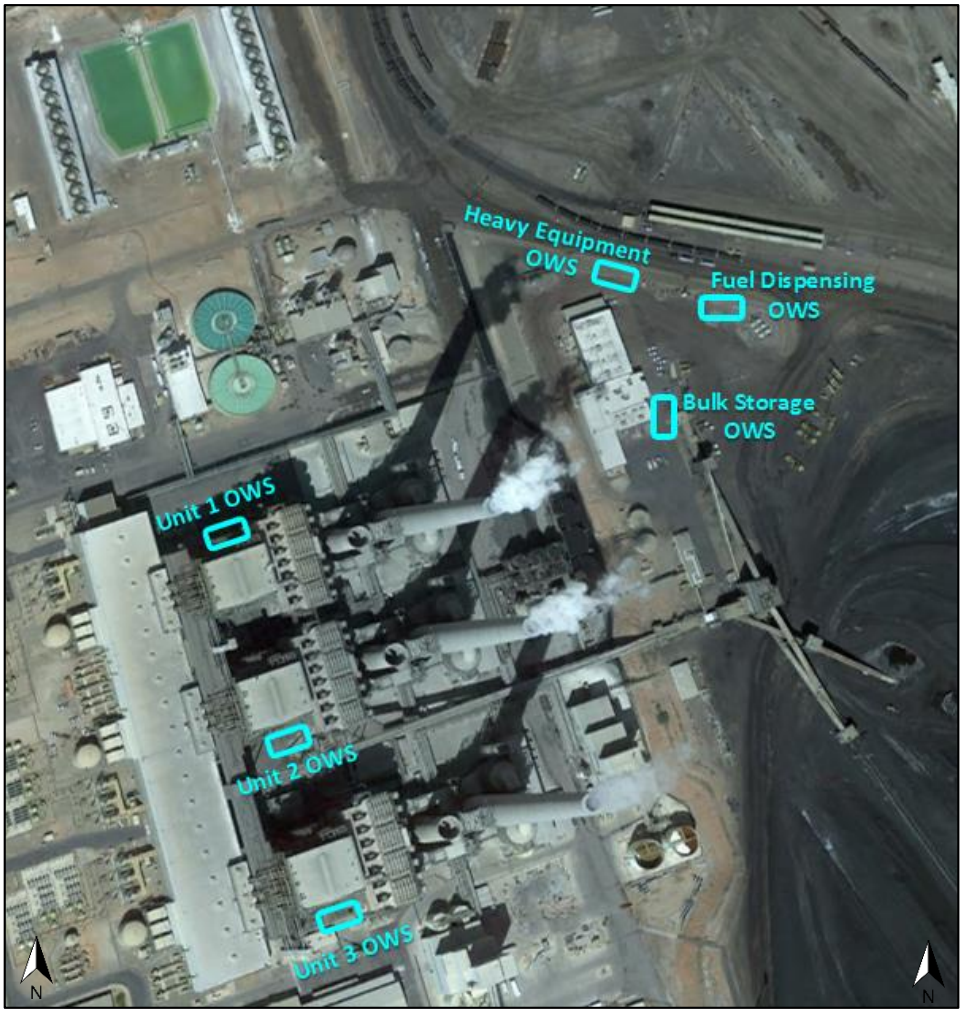


Figure 4: Oil-Water Separator Locations at NGS

4.2.1 Heavy Equipment Building Oil-Water Separator

The Heavy Equipment Building ("HE") OWS is located northeast of the building and collects oily-water from floor drains in the auto shop and pressure wash area. Processed water from the OWS is discharged to the onsite sewage treatment area and Pond S-1. The 3-vault separator has a capacity of 1,000 gallons.

4.2.1.1 Best Available Demonstrated Control Technology

The HE OWS is constructed of concrete.

4.2.2 Heavy Equipment Bulk Storage Oil-Water Separator

The Heavy Equipment Bulk Storage ("HEBS") OWS is located southeast of the building. This OWS only collects oily-water from the bulk storage sump drainage and normally remains isolated except during periodic sump cleanouts. In the event that the OWS receives sump drainage, the processed water is discharged into the HE OWS. The 3-vault separator has a capacity of 750 gallons.

4.2.2.1 Best Available Demonstrated Control Technology

The HEBS OWS is constructed of concrete and is lined with an epoxy coating.

4.2.3 Heavy Equipment Fuel Dispensing Oil-Water Separator

The Heavy Equipment Fuel Dispensing ("FD") OWS is located between the vehicle dispensing area and storage tanks. This OWS predominantly collects oily-water from the loading pads but can also collect leakage from the fuel pumps and transfer piping between the storage tanks and dispensing pumps. Process water is discharged to the storm drain that discharges to ADR-1. The 2-vault separator has a capacity of 1,000 gallons.

4.2.3.1 Best Available Demonstrated Control Technology

The FD OWS is constructed of concrete.

4.2.4 Unit 1 Oil-Water Separator

The Unit 1 ("U1") OWS collects oily-water from the service building sump, condenser pit sump, and miscellaneous drains[7] in the Unit 1 power block and discharges to Pond S-1 and Pond S-2. The 4-vault separator is located at northeast corner of the power block outside of the Unit 1 bottom ash area. The dimensions of the separator are 40 feet 8 inches by 13 feet 2 inches by 16 feet 1 inch.

4.2.4.1 Best Available Demonstrated Control Technology

The U1 OWS is constructed of 10-inch concrete and lined with an epoxy coating.

4.2.5 Unit 2 Oil-Water Separator

The Unit 2 ("U2") OWS collects oily-water from the condenser pit sump and miscellaneous drains in the Unit 2 power block and discharges to Pond S-1 and Pond S-2. The 4-vault separator is located at the southeast corner of the power block outside of the Unit 2 bottom ash area. The dimensions of the separator are 40 feet 8 inches by 13 feet 2 inches by 16 feet 1 inch.

4.2.5.1 Best Available Demonstrated Control Technology

Unit 2 OWS is constructed of 10-inch concrete and lined with an epoxy coating.

4.2.6 Unit 3 Oil-Water Separator

The Unit 3 ("U3") OWS collects oily-water from the air compressor room and auxiliary boilers, condenser pit sump, and miscellaneous drains in the Unit 3 power block and discharges to Pond S-1 and Pond S-2. The 4-vault separator is located at the southeast corner of the power block outside of the Unit 3 bottom ash area. The dimensions of the separator are 40 feet 8 inches by 13 feet 2 inches by 16 feet 1 inch.

[7] Miscellaneous drains (for all Unit OWSs) include: ash seal water booster pump drains, lube oil storage tank drains, ash system pump drains, boiler drains, 24" stand-pipe drain, acid cleaning connection, penthouse roof drains, and turbine deck roof drains.

4.2.6.1 Best Available Demonstrated Control Technology

Unit 3 OWS is constructed of 10-inch concrete and lined with an epoxy coating.

4.3 Ditches

Ditches at NGS are used to transport and divert various process waters.

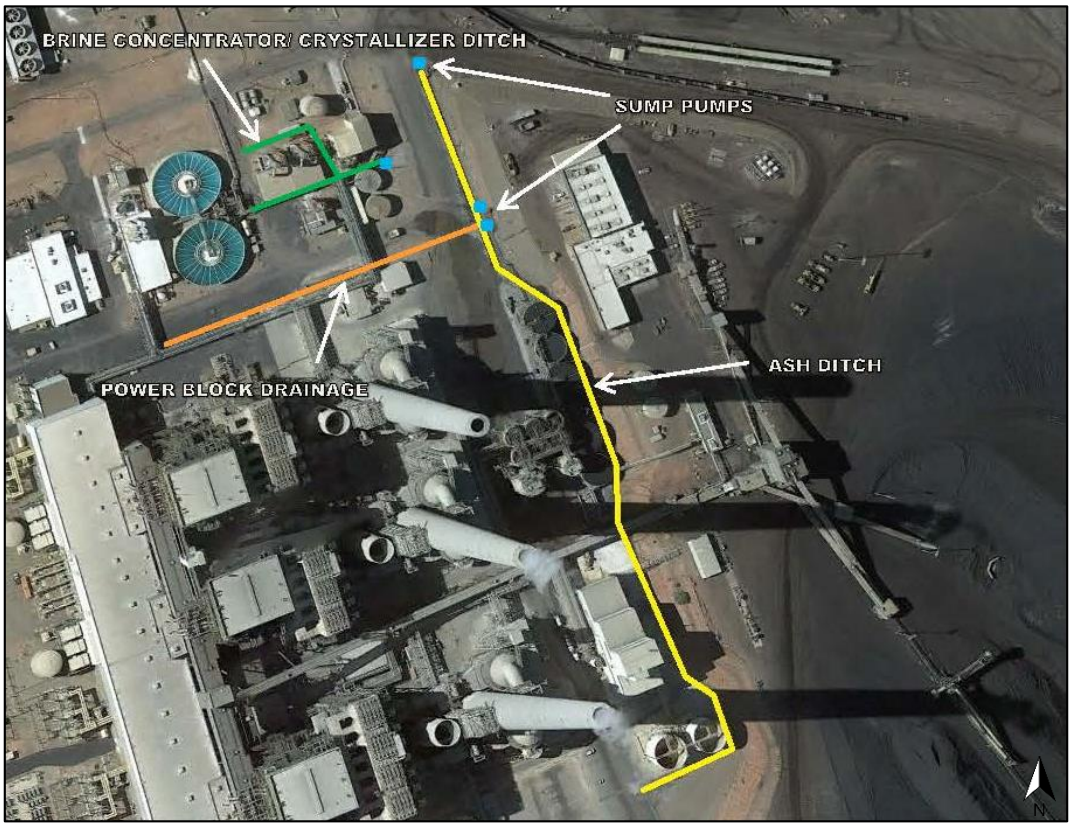


Figure 5: Ditch Locations at NGS

4.3.1 Ash Ditch

The Ash Ditch was constructed in the 1970s and modified in the 1990s when the ADR-2 Sump was installed. The ditch runs south to north near the dewatering bins and surge-and-settling tanks. The Ash Ditch is the largest ditch at NGS and is fed with water from the Power Block Drain Collection Ditch near sump ADR-2.[8] The ditch is deepest (4 feet) at its northern-most end where

[8] Sump ADR-2 pumps water back to the ash system to be used as bottom ash slurry.

sump ADR-1[9] is located. The Ash Ditch collects and transports a mixture of service water and process water with a high concentration of solids.

4.3.1.1 Best Available Demonstrated Control Technology

The Ash Ditch is concrete-lined.

4.3.2 Power Block Drain Collection Ditch

The Power Block Drain Collection Ditch was constructed in the 1970s and collects drainage from the Unit 1, 2, and 3 bottom ash areas. The drainage water includes: rainwater collected from concrete surfaces, bottom ash system washdown, bottom ash system leakage, and occasional upset-spillage from the bottom ash system and FGD slurry tanks located in the general area.

4.3.2.1 Best Available Demonstrated Control Technology

The Power Block Drain Collection Ditch is concrete-lined.

4.3.3 Brine Concentrator and Crystallizer Ditch

The Brine Concentrator and Crystallizer Ditch was installed in the 1980s and runs west to east along the north side of the BC 2&3 Building, southeast along the east side of the BC 2&3 Building, and then turns east along the south side of the Crystallizer Building. The Brine Concentrator and Crystallizer Ditch is fed by a feeder ditch that discharges blowdown from the three brine concentrators between the BC-1 and BC 2&3 Buildings. The ditch discharges at the Crystallizer Sump and then overflows to the Crystallizer Waste Sump, which is located to the east of the Crystallizer Building. Water from the waste sump is pumped to Pond 35-1 or 35-2. The discharge is high in chlorides, magnesium, and calcium.

4.3.3.1 Best Available Demonstrated Control Technology

The Brine Concentrator and Crystallizer Ditch is concrete-lined.

[9] Sump ADR-1 can pump water to Pond S-13.

4.4 Landfills

NGS supports three on-site landfills that are used to store asbestos-containing material, coal combustion residuals (e.g. bottom and fly ash, flue gas desulfurization material), and solid waste.

Figure 6: Solid Waste and Asbestos Landfills Locations at NGS

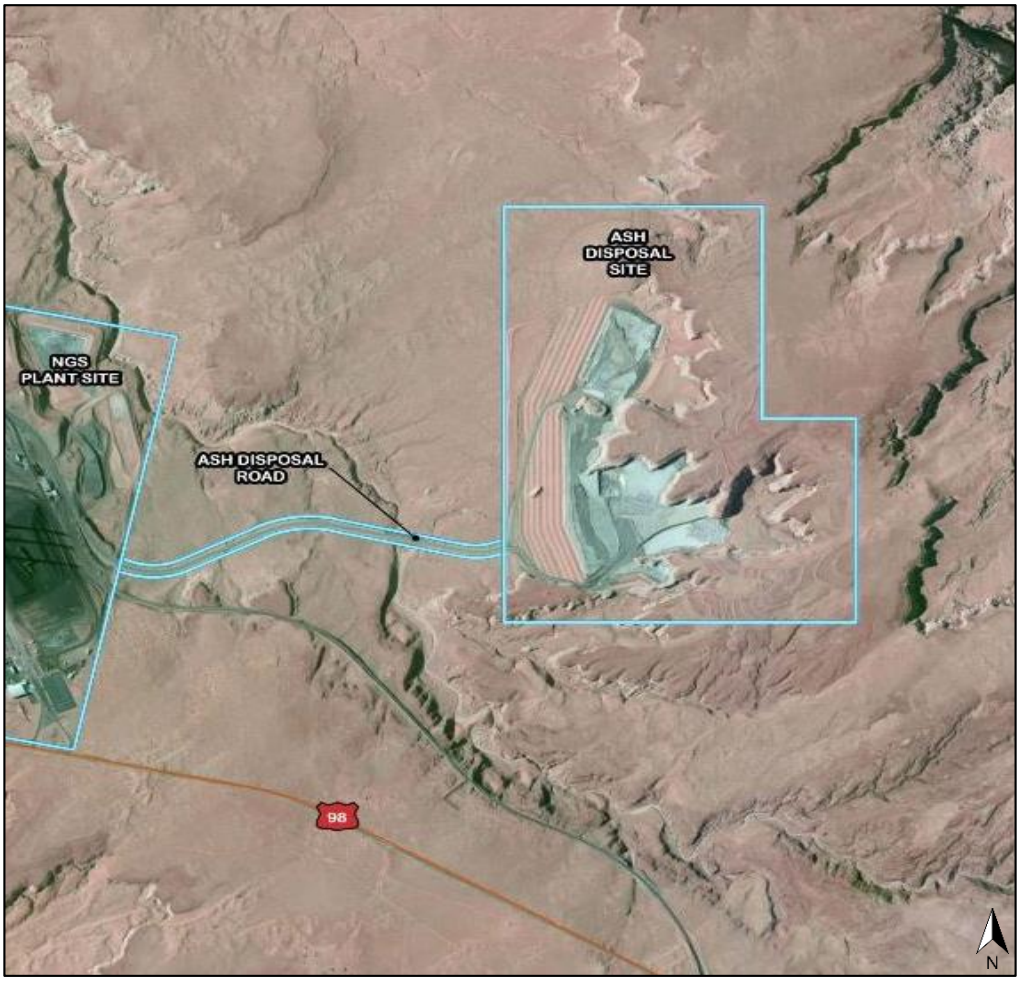


Figure 7: Ash Disposal Landfill Location at NGS

4.4.1 Asbestos Landfill

The Asbestos Landfill was permitted by the Environmental Protection Agency (EPA) in 1993 and lies south of the Solid Waste Landfill and to the southeast of the railroad loop area. The total site area is approximately six acres, and currently less than half of the site has been disturbed for landfill purposes. The active landfill area is approximately three acres and is enclosed by a gated steel-framed fence. The landfill only accepts asbestos waste generated on the plant site.

4.4.1.1 Best Available Demonstrated Control Technology

The Asbestos Landfill consists of a native soil base, which is unlined. Asbestos waste is deposited into cells which are 24 feet by 30 feet in size, and approximately 4 feet deep. Each

cell is marked with a wooden stake indicating the cell number. Large pieces of asbestos waste are wrapped with two layers of polyethylene sheeting and sealed with duct tape. Small pieces of waste are wetted and double-bagged with 6-mil polyethylene bags. All landfilled materials are covered with non-asbestos-containing soil and are applied in such a way that surface water does not collect on the surface of the landfill or run-off does not leave NGS property.

4.4.2 Ash Disposal Landfill

The Ash Disposal Landfill lies approximately one mile east of the NGS facility on 765 acres of leased land. The landfill was constructed in the early 1970s against the edge of a mesa outcrop in the Page/Navajo Sandstone Formation. The disposal capacity is approximately 38 million cubic yards of dry materials such as fly ash, economizer ash, bottom ash, and dewatered flue gas desulfurization (FGD) gypsum (i.e., calcium sulfate).

4.4.2.1 Best Available Demonstrated Control Technology

Sandstone bedrock serves as the base of the Ash Disposal Landfill along with the original layers of fly ash and bottom ash, which were placed as engineered fill and compacted with a sheep's foot vibrating compactor at optimum moisture. Borings indicate those original layers are the strength of lean concrete, providing a barrier to the aquifer which currently lies approximately 900 feet below. Ash material is deposited in horizontal terraces against the steep vertical walls of the sandstone outcrop. The use of dry disposal in conjunction with the dry climate and geology of the region reduces the mobility and leachability of any coal ash constituents. The western edge of the embankment is constructed as a series of small terraced fills to contain storm water run-off. On the eastern edge of the embankment a series of small berms were constructed as run-on controls.

4.4.3 Solid Waste Landfill

Solid waste produced at NGS is transported off-site for disposal or recycling. The Solid Waste Landfill was constructed in the early 1970s and lies east of the railroad loop area against the west edge of a mesa outcrop in the Navajo Sandstone Formation. The site area is approximately 13 acres.

In 2015 NGS determined the Solid Waste Landfill would no longer be utilized for routine waste disposal. The landfill was closed by covering its contents with native soil and grading the top surface. Future use will be governed by NGS management and environmental approval, limited to pre-approved construction project debris only. Routine waste is now disposed of off-site at an approved facility.

The materials approved for disposal in the landfill during 2000-2015 included:

- Rags that did not contain free liquid
- Alkaline batteries
- Sodium light bulbs and incandescent bulbs
- Emptied containers, excluding those which contained herbicides or pesticides
- Lunch room waste
- Non-recyclable paper waste (high finish glossy paper)

Items historically (prior to 2000) approved for disposal in the landfill included:

- Oil filters hot drained and crushed
- Drained and crushed 55 gallon drums
- Punctured and drained aerosol containers

4.4.3.1 Best Available Demonstrated Control Technology

Site-specific characteristics were the primary BADCT for the landfill. Sandstone served as the base of the landfill and the balance was of native soil. Terrace embankments were constructed in 6-foot lifts that were not to exceed the top of the embankment. A wind-litter fence was constructed on the eastern boundary of the landfill to minimize the dispersal of windblown debris.

5 MONITOR WELLS

SRP is undertaking measures to identify, monitor, and remove the isolated-perched-water that has formed beneath the main plant area and to ensure that water quality is not impacted in the deep N Aquifer. Groundwater and seepage monitor wells have been important in this mitigation effort and include: deep wells, shallow wells (includes dedicated, submersible pump back wells for removing perched water), and neutron wells (for measuring moisture content). The active monitoring wells and their pertinent details are described in Table 3, below. Currently, SRP conducts routine, semi-annual water level and/or water quality monitoring of these wells. Water quality monitoring includes conducting laboratory analyses for major ions, total dissolved solids, and metals.

5.1 Deep Wells

Three deep monitor wells (DW-1, DW-2, and DW-3) are covered under the *Groundwater Protection Plan* and monitor groundwater conditions in the N Aquifer at depths of 1,200 to 1,500 feet bgs. The wells are located at the north end of the ash disposal area (DW-3), in the railroad loop of the plant site (DW-2), and near Pond 60-2A at the north end of the plant site (DW-1); see Figure 8. These deep wells are monitored semi-annually for depth to groundwater and water quality parameters.

Figure 8: Deep Wells Covered Under the Groundwater Protection Program

5.2 Shallow Monitor Wells

Shallow monitor wells have been drilled at the plant site and ash disposal areas to depths of up to 70 feet bgs for the purpose of detecting possible seepage. The original wells were installed by Bechtel Corporation during NGS construction and startup activities between 1973 and 1975. SRP significantly expanded the monitoring program in 1978 by installing additional wells near the evaporation ponds, drainage ditches, cooling towers, power blocks of the plant site, and at the west end of the ash disposal area. In recent years, more shallow monitoring wells were added to the network to address the potential percolation of the perched water. Some of the shallow monitoring wells have been equipped with dedicated positive displacement pumps to recycle perched water back to the plant systems (i.e. pump back wells). See Figure 9, below, for the locations of the shallow monitoring wells located near potential areas of perched water. Wells marked by an asterisk (*) indicate an active pump back well. Shallow monitoring wells and pump back wells are monitored semi-annually for the presence-absence of water, static water level, or water quality parameters. Unless sufficient water is present in the shallow monitoring wells, water quality samples are only taken for the pump back wells.[10]

5.3 Neutron Wells

Sixteen neutron wells were installed in 1978 to depths ranging from 50-149 ft bgs for purposes of monitoring changes in subsurface moisture conditions in the unsaturated zone beneath the plant site and ash disposal area. One additional neutron well, located in the ash disposal area, was installed in 1997 to a depth of 445 ft bgs. The original 16 neutron wells have since been disturbed by plant reconstruction or abandoned for other reasons. It should be noted that the deep wells were also used for neutron logging purposes in the past.

5.4 Exempt Wells

Over time, some wells have been disturbed by plant reconstruction, modified or abandoned to prevent vertical conduit issues, or have been abandoned for other reasons. These wells are not covered under the *Groundwater Protection Plan* and are not subject to semi-annual monitoring.

[10] It is anticipated that MW-29 will be converted from a shallow monitoring well to a pump back well in late-2017. The well has accumulated enough water for water quality samples to be collected semi-annually.

Figure 9: Active Monitor Wells near Potential Areas of Perched Water

Table 3: Active Monitoring Wells

Well ID	Monitoring Well Type	Drill Date	Well Depth (ft bgs)	Latitude (NAD83)	Longitude (NAD83)
DW-1	Deep	2/26/1979	1,200	N36°54.932'	W111°23.825'
DW-2	Deep	11/25/1981	1,500	N36°54.442'	W111°23.229'
DW-3	Deep	11/25/1981	1,500	N36°54.897'	W111°23.435'
NEX-3	Shallow/Pump Back	7/26/1978	16	N36°54.502'	W111°25.427'
MW-6	Shallow	11/1/1973	41	N36°54.927'	W111°23.306'
MW-7R	Shallow/Pump Back	10/24/2013	41	N36°54.870'	W111°23.182'
MW-19	Shallow	11/15/1973	20	N36°54.731'	W111°23.145'
MW-21	Shallow	12/10/1975	27	N36°54.984'	W111°23.738'
MW-23	Shallow	6/15/1978	23	N36°54.620'	W 111°24.013'
MW-27R	Shallow/Pump Back	12/20/2013	55	N36°54.438'	W111°23.401'
MW-29	Shallow	11/ 23/2015	50	N36°54.524'	W111°23.454'
MW-30	Shallow	7/3/1978	22	N36°54.333'	W111°23.665'
MW-31R	Shallow/Pump Back	10/22/2013	36	N36°54.375'	W111°23.591'
MW-32A	Shallow	6/28/1978	41	N36°54.432'	W111°23.693'
MW-32B	Shallow	6/28/1978	41	N36°54.432'	W111°23.693'
MW-33	Shallow	6/29/1978	10	N36°54.452'	W111°23.632'
MW-40R	Shallow/Pump Back	12/17/2013	38	N36°53.941'	W111°23.376'
MW-41R	Shallow/Pump Back	12/21/2013	21	N36°53.982'	W111°23.268'
MW-42R	Shallow/Pump Back	12/16/2013	25	N36°54.012'	W111°23.377'
MW-43	Shallow	7/14/1978	21	N36°54.027'	W111°23.329'
MW-56	Shallow	8/19/1980	19	N36°54.902'	W111°23.840'
MW-57	Shallow	8/19/1980	35	N36°54.985'	W111°23.565'
MW-62	Shallow	8/22/1980	45	N36°54.752'	W111°23.380'
MW-63	Shallow	8/22/1980	21	N36°54.384'	W111°23.805'
MW-64	Shallow	10/11/1985	25	N36°54.304'	W111°23.432'
MW-65	Shallow/Pump Back	10/12/1985	28	N36°54.344'	W111°23.395'
MW-66	Shallow/Pump Back	10/12/1985	28	N36°54.348'	W111°23.338'
MW-68	Shallow	10/1/1985	25	N36°54.308'	W111°23.502'
MW-69	Shallow	10/1/1985	13	N36°54.351'	W111°23.447'
MW-70	Shallow	10/1/1985	13	N36°54.205'	W111°23.366'
MW-71	Shallow	10/1/1985	23	N36°54.299'	W111°23.536'
MW-73	Shallow/Pump Back	10/24/2013	37	N36°54.389'	W111°23.347'
MW-74	Shallow/Pump Back	11/ 21/2015	30	N36°54.348'	W111°23.549'

6 INSPECTIONS

To verify that all systems are functioning properly and performance standards are being met, monthly inspections are conducted for the ponds, OWSs, ditches, and landfills. The inspection processes are divided between two groups at NGS. NGS Operations is responsible for inspecting the ponds, OWSs, and ditches and NGS Environmental is responsible for inspecting the landfills. All inspections are conducted on a monthly basis and include the best practice criteria emphasized in the tables below. Inspection dates and significant findings are recorded in the electronic *Groundwater Protection Plan Logbook* and the completed inspection forms are to be retained for ten years. The *Groundwater Protection Plan Logbook* and completed inspections are maintained electronically on the NGS share drive.

6.1 Pond Inspections

Table 4a: 35-Series Ponds

Parameter	Performance Standard	Monitoring Frequency	Internal Reporting Frequency
Liner Integrity	No visible cracks, punctures, or deteriorations of liner	Monthly	Annually
Berm Integrity	No visible structural weakness, seepage erosion, or other hazardous conditions	Monthly	Annually
Freeboard	Minimum of 2 feet	Monthly	Annually
Leakage from French Drain	No color change in the drain	Monthly	Annually

Table 4b: 60-Series Ponds

Parameter	Performance Standard	Monitoring Frequency	Internal Reporting Frequency
Liner Integrity	No visible cracks, punctures, or deteriorations of liner	Monthly	Annually
Dam and Berm Integrity	No visible structural weakness, seepage erosion, or other hazardous conditions	Monthly	Annually
Freeboard	Minimum of 2 feet	Monthly	Annually
Leachate Collection and Leak Monitoring Systems	All systems and structures in good integrity and functioning properly	Monthly	Annually

Table 4c: SD-Series Dry Ponds

Parameter	Performance Standard	Monitoring Frequency	Internal Reporting Frequency
Liner Integrity	No visible cracks, punctures, or deteriorations of liner	Monthly	Annually
Berm Integrity	No visible structural weakness, seepage erosion, or other hazardous conditions	Monthly	Annually
Leachate Collection System	In good integrity	Monthly	Annually

Table 4d: S-Series Ponds

Parameter	Performance Standard	Monitoring Frequency	Internal Reporting Frequency
Liner Integrity	No visible cracks, punctures, or deteriorations of liner	Monthly	Annually
Berm Integrity	No visible structural weakness, seepage erosion, or other hazardous conditions	Monthly	Annually
Freeboard	Minimum of 2 feet	Monthly	Annually
Oil Sheen	No oil sheen on ponds	Monthly	Annually
Leachate Collection System	In good integrity	Monthly	Annually

Table 4e: SR-Series Ponds

Parameter	Performance Standard	Monitoring Frequency	Internal Reporting Frequency
Freeboard	Minimum of 2 feet	Monthly	Annually

Table 4f: Makeup Reservoir (Pond A and Pond B)

Parameter	Performance Standard	Monitoring Frequency	Internal Reporting Frequency
Liner Integrity	No visible cracks or damage in concrete that could impact soil	Monthly	Annually
Freeboard	Minimum of 2 feet	Monthly	Annually

Table 4g: NE-Series Ponds

Parameter	Performance Standard	Monitoring Frequency	Internal Reporting Frequency
Berm Integrity	No visible structural weakness, seepage erosion, or other hazardous conditions	Monthly	Annually
Freeboard	Minimum of 2 feet	Monthly	Annually
Leachate Collection System	In good integrity	Monthly	Annually

6.2 Oil-Water Separator Inspections

Table 5: Heavy Equipment Area and Unit OWSs

Parameter	Performance Standard	Monitoring Frequency	Internal Reporting Frequency
Performance	No obvious signs of petroleum bypassing the separator	Monthly	Annually
Cleanliness	No trash, debris, or sediment around inlets, outlets, or drains. No spills or overflows. Good housekeeping is evident	Monthly	Annually
Preparedness	Spill sorbent materials readily available	Monthly	Annually
Surface Integrity	No significant damage, cracks, or extensive corrosion	Monthly	Annually
Sludge buildup	Vaults not overloaded with sludge	Monthly	Annually
Internal Integrity	No obvious visual signs of cracks, erosion, or other internal damage	Monthly	Annually

6.3 Ditch Inspections

Table 6: Ash, Brine Concentrator, and Crystallizer Ditches

Parameter	Performance Standard	Monitoring Frequency	Internal Reporting Frequency
Sediment and Buildup	No obstructions that impair the function of the collection system	Monthly	Annually
Liner Integrity	No visible cracks or damage in concrete that could impact soil	Monthly	Annually

6.4 Landfill Inspections

Table 7: Asbestos, Ash, and Solid Waste Landfills

Parameter	Performance Standard	Monitoring Frequency	Internal Reporting Frequency
Cap/Structural Integrity	No surface subsidence or settlement, no ponding water, no visible erosion	Monthly & after any significant rainfall or storm event	Annually
Standing Water	No discolored standing water present	Monthly & after any significant rainfall or storm event	Annually

7 MONITORING

Groundwater monitoring will continue for the remaining life of NGS as part of the best management practice for the facility. All sampling, preservation, and holding times will be in accordance with currently-accepted standards of professional practice. Trip blanks, equipment blanks, and duplicate samples will be used as necessary and Chain-of-Custody procedures will be followed in accordance with the currently-accepted standards of professional practice. Copies of laboratory analyses and Chain-of-Custody forms will be maintained at NGS and the SRP Laboratory.

7.1 Oil-Water Separator Sampling

NGS Operations and NGS Environmental are responsible for working together to perform routine discharge monitoring for the OWSs at NGS (i.e., Unit 1 (U1), Unit 2 (U2), and Unit 3 (U3) OWSs and the Heavy Equipment Building (HE), Heavy Equipment Bulk Storage (HEBS), and Heavy Equipment Fuel Dispensing (FD) OWSs) to ensure that the quality of the effluent meets specific performance standards.

- Twice per year, NGS Environmental conducts discharge monitoring at each Unit OWS and the HE OWS to identify levels of oil and grease. Discharge monitoring at the HEBS and FD OWSs is conducted on an as-needed basis, depending on the monthly inspections.[11]
- Twice per year, each Unit OWS and the HE OWS are routinely cleaned using the vacuum truck and flushed. Routine cleaning is also conducted in the HEBS and FD OWSs, but on an as-needed basis depending on the monthly inspections.[12]

7.2 Water Sampling

Routine groundwater and perched water sampling is conducted at NGS as part of the best management practices. On a semi-annual basis, depth to groundwater is measured and routine groundwater samples are collected from deep wells DW-1, DW-2, and DW-3. Samples are collected

[11] The HEBS and FD OWSs do not receive constant inflow and are expected to accumulate oil and grease more slowly than the Unit OWSs and the HE OWS, which receive constant inflow.
[12] See previous footnote.

from DW-1 and DW-2 with a stainless steel bailer and cable tool, and samples are collected from DW-3 using a submersible pump.

In addition, on a semi-annual basis when sufficient water is present, the shallow monitoring wells are measured for static water level (only if the respective well does not have a dedicated submersible pump or if the pump is not pumping) and water quality samples are collected from NEX-3, MW-7R, MW-27R, MW-29, MW-31R, MW-40R, MW-41R, MW-42R,MW-43R, MW-65, MW-66, MW-73, and MW-74. If the dedicated pumps are out of service, the samples are collected with a disposable bailer.

Routine water quality monitoring parameters of interest for both the deep and shallow wells are: Arsenic, Barium, Cadmium, Chromium, Lead, Selenium, Fluoride, Sulfate, and Total Dissolved Solids (TDS). The monitoring thresholds (MTs) and respective Federal Maximum Contaminant Levels (MCLs) for these constituents are listed in Table 10 for the deep water monitoring wells. Perched water wells are not subject to aquifer water quality standards, therefore, no MTs will be established for these wells. However, these wells will continue to be monitored for static water level and water quality.

SRP's Field Services conducts the groundwater sampling at NGS. Deep well DW-3 is purged of at least three borehole volumes (as calculated using the static water level) or until indicator parameters (pH, temperature, and conductivity) are stable. If evacuation results in the well going dry, the well will be allowed to recover to 80 percent of the original borehole volume, or for 24 hours, whichever is shorter, prior to sampling. If there is not sufficient water for sampling after 24 hours, the well will be recorded as "dry" for the monitoring event.

7.2.1 Deep Well Replacement

In the event that one of the deep wells becomes unusable or inaccessible due to damage for more than two sampling events, or any other event, a replacement well will be constructed and installed. If the replacement well is 50 feet or less from the original well, the threshold levels and limits calculated for the designated deep well can apply to the replacement well. Otherwise, the threshold levels and limits will be recalculated for the replacement well.

8 ANALYTICAL METHODOLOGY

All groundwater samples collected for compliance monitoring are analyzed in-house at SRP's State Certified Laboratory Services (Tempe, Arizona) or by other appointed subcontractors, using Arizona state-approved methods. Laboratory Services is licensed by the Arizona Department of Health Services, Office of Laboratory Licensure and Certification, license number AZ0081. If no state-approved method exists, then any appropriate EPA-approved method will be used. Regardless of the method used, the detection limits must be sufficient to determine adherence to the parameter limits specified in this *Groundwater Protection Plan*. All analytical work will meet quality control standards specified in the approved methods or be qualified accordingly.

9 LIMITS ESTABLISHED FOR NGS

NGS has adopted alert levels (AL) for leakage rates and monitoring thresholds (MT) for contaminant concentrations, which are reported as gallons per day (gpd) and milligrams per liter (mg/L), respectively. The MTs are based on the primary Federal maximum contaminant levels (MCLs) established by the EPA,[13] with the exception of the MTs for total dissolved solids (TDS) and sulfate, which are based on the secondary MCLs (i.e. National Secondary Drinking Water Regulations that are non-enforceable guidelines).[14]

[13] The MT is a pre-alert trigger for the MCL; MT= MCL*0.80.
[14] The EPA has not established primary MCLs for TDS or sulfate, but it has established National Secondary Drinking Water Regulations for these constituents.

Table 8: Pond Leachate Recovery Monitoring

Source	Parameter	AL1 (gpd)	AL2 (gpd)	Monitoring Frequency[15]	Reporting Frequency
Pond 60-1A	Liquid Detected	3,572	114,024	Monthly	Annually
Pond 60-1B	Liquid Detected	4,166	133,000	Monthly	Annually
Pond 60-2A	Liquid Detected	4,203	134,173	Monthly	Annually
Pond 60-2B	Liquid Detected	4,255	135,844	Monthly	Annually
Pond 60-2C	Liquid Detected	815	26,028	Monthly	Annually
Pond 60-2D	Liquid Detected	797	25,445	Monthly	Annually
Pond S-1	Liquid Detected	415	13,240	Monthly	Annually
Pond S-2	Liquid Detected	372	11,859	Monthly	Annually
Pond S-3	Liquid Detected	533	17,023	Monthly	Annually
Pond S-13	Liquid Detected	1,392	44,448	Monthly	Annually

Notes for Table 8:
Each pond has its own monitoring system that is used to detect leaks. Alert Level 1 (AL1) or Alert Level 2 (AL2) is exceeded when leakage detected by each respective monitoring system is greater than the quantity specified above.

[15]Leakage quantification will be performed monthly while the impoundment is "in use" (i.e., when industrial water is present in the impoundment and/or sump). Evacuation of fluids in the sump will be performed as necessary for accurate monitoring and effective operation of the collection system.

Table 9: Oil-Water Separator Discharge Monitoring

Category	Parameter	MT (mg/L)	Monitoring Frequency	Reporting Frequency
Petroleum	Oil & Grease	15	Twice per year	Annually, beginning 2014
	Total Petroleum Hydrocarbons (TPH)	50	One time event only	Initial discharge characterization report completed in 2014
Volatile Organic Compounds	Acetone	NE	One time event only	Initial discharge characterization report completed in 2014
	Benzene			
	Chlorobenzene			
	Chloroform			
	1,2,-Dichlorobenzene			
	1,3-Dichlorobenzene			
	1,4-Dichlorobenzene			
	2-Butanone (MEK)			
	Ethylbenzene			
	Tetrachloroethylene			
	Toluene			
	1,1,1-Trichloroethane			
	1,1,2-Trichloroethane			
	Trichloroethylene			
	Vinyl Chloride			
	Total Xylenes			
Semi-Volatile Organic Compounds	Di-(2-ethylhexyl) adipate			
	Di-(2-ethylhexyl) phthalate			
	1,2,4-Trichlorobenzene			
	Hexachlorobenzene			
	Pentachlorophenol			
	2-Methylnaphthalene			
	Naphthalene			
	Phenanthrene			
	Fluoranthene			
	Chrysene			
	Benzo(b)Fluoranthene			
	Benzo(a)Pyrene			
	Indeno(1,2,3-cd)Pyrene			

Notes for Table 9:

NE= None established

Monitoring frequency for oil and grease was once per year from 2014 through 2016. Semi-annual monitoring began in 2017.

Table 10: DW-1, DW-2, and DW-3 Routine Water Quality Monitoring†

Parameter	MT (mg/L)	MCL (mg/L)	Sampling Frequency	Reporting Frequency
Metals (Total Recoverable)				
Arsenic	0.008	0.010	Semi-annually	Annually
Barium	1.6	2.0	Semi-annually	Annually
Cadmium	0.004	0.005	Semi-annually	Annually
Chromium	0.08	0.10	Semi-annually	Annually
Lead	0.012	0.015*	Semi-annually	Annually
Selenium	0.04	0.05	Semi-annually	Annually
Major Cations and Anions				
Fluoride	3.2	4.0	Semi-annually	Annually
Sulfate**	200	250	Semi-annually	Annually
Total Dissolved Solids (TDS)**	400	500	Semi-annually	Annually

Notes for Table 10:

† The pump back wells are tested for the parameters listed, but the analytical results are not compared to the MTs or MCLs since the standards do not apply to perched water.

**Lead is regulated by a treatment technique that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps.*

*** The EPA has not established primary MCLs for TDS or sulfate. The secondary MCLs were used in lieu of primary MCLs and the MT values based on secondary MCL.*

10 CONTINGENCY PLAN FOR EMERGENCIES

NGS Operations and NGS Environmental are responsible for implementing contingency plans whenever there is a deviation from the AL, MT, MCL, or any other condition covered in the *Groundwater Protection Plan*. NGS Operations and NGS Environmental will maintain a copy of the *Groundwater Protection Plan* at an accessible location where decisions are made regarding the operation of the facility. This document must be used to inform decision-making whenever any occurrence triggers a contingency plan, and the occurrence that triggered the contingency plan must be documented in the *Groundwater Protection Plan Log Book*.

Some contingency actions involve issuing an internal notification to dedicated staff and/or conducting verification sampling. The Internal Notification Distribution Lists includes:

NGS Environmental:		
Debora Saliego	Senior Environmental Engineer	**(928) 645-6573**
Mario Gorman	Environmental Engineer Associate	**(928) 645-6596** **(928) 640-1374 cell**
Jon Ridpath	Maintenance Specialist Plant Mechanic	**(928) 645-6573** **(928) 640-7685 cell**
Paul Ostapuk	O&M Manager	**(928) 645-6577** **(928) 614-9655 cell**
NGS Operations:		
Shift Supervisor	Shift Supervisor	**(928) 645-7213**
Johnny Klain	O&M Supervisor	**(928) 645-6252** **(928) 614-9784 cell**
Ed Irvin	O&M Manager	**(928) 645-6255** **(928) 640-0072 cell**
SRP Environmental Compliance and Permitting:		
Andrea Martinez	Principal Environmental Compliance Engineer	**(602) 236-2618** **(602) 621-0214 cell**
Dave Sultana	Water Quality Waste Management Field Services Manager	**(602) 236-8118** **(602) 809-9616 cell**
SRP Groundwater (if applicable to groundwater):		
Karol Wolf	Senior Geohydrologist	**(602) 236-5767** **(602) 466-4645 cell**

Verification sampling entails collecting a follow-up sample from a location that previously indicated an exceedance of an MT or MCL in a deep well. Collection and analysis of the verification sample will use the same protocols and test methods which were used on the initial sample.

10.1 Facility Inspection Findings

NGS Environmental or NGS Operations must follow the applicable contingency requirements and document all analyses, repairs, or training in the *Groundwater Protection Plan Logbook*.

10.1.1 Freeboard Height

In the event that freeboard performance standards[16] are not maintained for a given pond, NGS Operations will:

1. Issue an internal notification.
2. Immediately cease or reduce discharging to the reservoir to prevent overtopping and properly dispose of excess water in the reservoir until the water level is restored at or below the freeboard level for the impoundment.
3. Evaluate the cause of the incident and adjust operational conditions as necessary to avoid future occurrences.
4. Document all analyses, repairs, or training in the *Groundwater Protection Plan Logbook*.

10.1.2 Oil-Water Separator Capacity

In the event that any OWS exceeds its maximum capacity (i.e., design flow and sludge depth)[17] and is evidently discharging oil to Pond S-1 or Pond S-2 (i.e., sheen present on ponds), NGS Operations and NGS Environmental will:

1. Issue an internal notification within 10 days of discovery.
2. Determine source of oil and grease contamination.
3. Reduce source flow into the separator, if possible.
4. Remove excess sludge from oil-separator compartments, if necessary.

[16] Performance standards are covered in Section 6 of the *Groundwater Protection Plan*.
[17] Specific performance standards for the OWSs are described elsewhere and are not included in the *Groundwater Protection Plan*.

5. Remove excess oil from Pond S-1 or Pond-S2 using oil absorbents, if necessary.
6. Evaluate the cause of the incident and adjust operational conditions as necessary to avoid future occurrences.
7. Document all analyses, repairs, or training in the *Groundwater Protection Plan Logbook*.

10.1.3 Pond, Ditch, Oil-Water Separator, and Landfill Integrity

In the event that the integrity[18] of any component of the ponds, berms, dams, ditches, OWS, or landfills has been compromised, NGS Operations and NGS Environmental will:

1. Issue an internal notification.
2. Determine why the integrity of the structure or area is being compromised.
3. Ensure necessary repairs to return the area or structure to the proper operational or closed status.
4. Document all analyses, repairs, or training in the *Groundwater Protection Plan Logbook*.

10.2 Exceeding Alert Levels or Monitoring Thresholds

NGS Environmental or NGS Operations must follow the applicable contingency requirements and document all analyses, repairs, or training in the *Groundwater Protection Plan Logbook*.

10.2.1 Water Seepage/Leakage Rate

Two alert levels (AL1 and AL2) have been established for Ponds 60-1A, 60-1B, 60-2A, 60-2B, 60-2C, 60-2D, S-1, S-2, S-3, and S-13. Each alert level triggers a separate contingency plan.

10.2.1.1 Alert Level 1

If the leakage rate exceeds the respective AL1, as part of the best management practice NGS Operations will:

1. Increase monitoring frequency of the sump to daily.
2. Issue an internal notification if the seepage rate exceeds the AL1 more than four consecutive days.

[18] Performance standards are covered in Section 6 of the *Groundwater Protection Plan*.

3. Assess the cause of excess fluid in the sump through liner evaluation or other testing.
4. Identify and implement corrective action or repair.
5. Document all analyses, repairs, or training in the *Groundwater Protection Plan Logbook*.

10.2.1.2 Alert Level 2

If the leakage rate exceeds the respective AL2, as part of the best management practice NGS Operations will:

1. Immediately issue an internal notification.
2. Reduce or cease discharge into the ponds, if possible.
3. Assess the cause of excess fluid in the sump through evaluation of the liner systems using visual methods, electrical leak detection, or other applicable testing methods.
4. Identify and implement corrective action or repair.
5. Document all analyses, repairs, or training in the *Groundwater Protection Plan Logbook*.

10.2.2 Oil-Water Separator Monitoring Threshold

The OWS MTs serve as indicators that a separator is not functioning properly and may be impaired by the buildup of oily-waste sludge. If an MT for the Heavy Equipment Building, Heavy Equipment Bulk Storage, Heavy Equipment Fuel Dispensing, Unit 1, Unit 2, or Unit 3 OWS is exceeded for oil and grease, NGS Operations or NGS Environmental will:

1. Issue an internal notification within 10 days of discovery.
2. Conduct verification sampling within 10 days of becoming aware of an MT violation.
3. Determine source of oil and grease contamination.
4. Document all analyses, repairs, or training in the *Groundwater Protection Plan Logbook*.

If the verification sampling confirms that the MT is exceeded for any parameter, NGS Operations or NGS Environmental will:

1. Cease or reduce source flow into the separator.
2. Evaluate the cause of the incident and implement corrective action or repair. Adjust operational conditions as necessary to avoid future occurrences.

3. Document all analyses, repairs, or training in the *Groundwater Protection Plan Logbook*.

10.2.3 Groundwater Monitoring Threshold Limits

The groundwater MTs serve as an early indicator that discharge of a pollutant may have occurred. If an MT for deep wells DW-1, DW-2, DW-3 is exceeded for one of the parameters, as part of best management practice NGS Environmental will:

1. Issue an internal notification within 10 days of discovery.
2. Conduct verification sampling within 30 days of becoming aware of an MT violation.

If the verification sampling confirms that the MT is being exceeded, NGS Environmental will:

1. Issue an internal notification within 10 days of discovery.
2. Increase the frequency of the monitoring from semi-annually to quarterly.
3. Investigate the cause of the MT being exceeded, including inspection of all discharging units and related pollution control devices and reviewing any operational and maintenance practices that might have resulted in an unexpected discharge.
4. Identify and implement corrective actions or repairs.
5. Issue an internal notification which summarizes the findings of the investigation, the cause of the MT being exceeded, and actions taken to resolve the problem.
6. Resume semi-annual sampling if the results of four sequential quarterly sampling events demonstrate that no parameters exceed the MTs.
7. Document all analyses, repairs, or training in the *Groundwater Protection Plan Logbook*.

10.3 Exceeding Maximum Contaminant Levels[19]

If an MCL for deep wells DW-1, DW-2, or DW-3 has been exceeded, NGS Environmental will:

1. Issue an internal notification within 10 days of discovery.
2. Conduct verification sampling within 30 days of becoming aware of an MCL violation.

[19] For the ash disposal site (and associated monitoring wells), monitoring, sampling, assessment, and corrective measures will comply with the CCR Management rule (80 FR 21301-21501) and regulations (40 CFR §257).

If the verification sampling confirms that the MCL is exceeded for any parameters, NGS Environmental will:

1. Issue an internal notification within 10 days of discovery.
2. Increase the frequency of monitoring from semi-annually to quarterly.
3. Immediately initiate the evaluation for the cause of the exceedance, including inspection of all discharging units and all related pollution control devices, and review any operational and maintenance practice that might have resulted in the exceedance. Take other action as necessary and appropriate.
4. Identify and implement corrective action or repairs.
5. Document all analyses, repairs, or training in the *Groundwater Protection Plan Logbook*.

10.4 Spills

A spill of any fluid onto the vadose zone at NGS is subject to documentation on the *Spill Report Form* and is circulated to an internal notification list.[20] If a spill of one gallon or more of hazardous substance (e.g., hazardous materials, petroleum products, etc.) reaches the soil, NGS Environmental will:

1. Ensure the spill is cleaned up and soil is excavated, as applicable.[21]
2. Identify the cause of the spill and implement corrective actions.
3. Document all analyses, repairs, or training in the *Groundwater Protection Plan Logbook*.

10.5 Discharge of Unauthorized Materials

Materials which are authorized for discharge or disposal in the ponds, ditches, OWSs, and landfills are described in Section 4. Any materials not described in the respective subsections are not authorized for discharge or disposal. If any unauthorized materials are discharged into a pond, ditch, or OWS, or if any unauthorized materials are disposed of in a landfill of any type, NGS Environmental or NGS Operations will:

1. Immediately ensure the cessation of all unauthorized discharges or disposals.

[20] The internal distribution list is described above, under Section 10.
[21] Refer to the *NGS Emergency Response Plan* for regulatory spill procedures.

2. Immediately issue an internal notification.
3. Identify the source of the material and the cause for unauthorized discharge or disposal.
4. Characterize the unauthorized material and contents of the affected pond, ditch, or landfill, and if possible, evaluate the compatibility of the discharged material into the pond or ditch. If the pond liner is damaged or degraded by the unauthorized discharge, conduct an assessment of the impacts to the subsoil and/or groundwater resulting from the incident.
5. Based on assessment, identify and implement corrective actions or repairs.
6. Document all analyses, repairs, or training in the *Groundwater Protection Plan Logbook*.

11 ANNUAL INTERNAL REPORTING

SRP Environmental Compliance and Permitting, NGS Environmental, and SRP Groundwater are responsible for preparing and submitting a groundwater report to NGS Environmental Management and SRP Environmental Compliance and Permitting on an annual basis. The report will be submitted by June 30 of each year to cover the activities performed between January 1 and December 31 of the previous calendar year. The annual report, after review and approval by NGS and SRP Environmental Compliance and Permitting management, will be provided to the NGS Participants by December 31. The annual report will briefly summarize the status of the *Groundwater Protection Plan* and will include:

- Significant inspection findings
- Any repairs made as a result of the inspection findings
- MTs and MCLs that were exceeded
- Any contingency actions performed
- *A Groundwater Monitoring Report* that will include:
    - Tabulated summary of monitoring data for all deep water and pump back wells
    - Summary of all MT and MCL exceedances
    - Groundwater elevation data for each sampling round
    - Groundwater contour maps for each sampling round
    - Groundwater flow calculations for each sampling round
    - Assessment of groundwater flow and adequacy of the well locations with respect to groundwater flow
    - Trending analysis for constituents of concern where data approaches the MT
    - Certified laboratory reports

12 CLOSURE

When a pond or landfill covered under the *Groundwater Protection Plan* has reached the end of its useful life and will no longer be operated to meet its engineered function, NGS will conduct closure and post-closure activities according to the plans outlined below.[22]

12.1 Pond and Landfill Closure Plan

A Professional Engineer (PE) will develop an industry-recognized and generally-accepted good engineering practices closure plan. This plan will include, but is not limited to:

- Testing soil constituents in or adjacent to the respective decommissioned pond or landfill.
- Comparing soil test results to EPA residential and industrial regional screening levels (RSLs) and either:

    1) Removing or decontaminating areas if soil constituents exceed applicable Federal levels; or

    2) Closing the area with materials in place if soil constituents fall below applicable Federal levels.

- Eliminating free liquids or solidifying remaining wastes and waste residues, where needed, to support the final cover.
- Stabilizing remaining wastes and waste residues, to the degree necessary, to support the final cover.
- Installing final cover per the requirements of the designated PE.
- Control soil erosion and/or establish an infiltration barrier system that exhibits maximum permeability and controls run-on and run-off in the designated area.

12.2 Pond and Landfill Post-Closure Care Plan

The PE will recommend the type and duration of post-closure activities. At a minimum, the post-closure care plan will entail industry best practice elements, which may include:

[22] For the ash disposal site, closure and post-closure monitoring will comply with the CCR Management rule (80 FR 21301-21501) and regulations (40 CFR §257).

- Maintaining the integrity of the final cover system, including making repairs as necessary to correct the effects of settlement, subsidence, erosion, or other events.
- Preventing run-on and run-off from eroding, or otherwise damaging, the final cover.
- Maintaining the integrity and effectiveness of the leachate collection and removal system, and operating these systems according to their design criteria.
- Maintaining the groundwater monitoring system and monitoring groundwater according to PE recommendations.

APPENDIX 1: PERCHED WATER DEWATERING WORK PLAN

Perched Water Dewatering Work Plan

Navajo Generating Station

Prepared by SRP
Updated January 30, 2015
Rev 4

Table of Contents

Tables

Figures

PERCHED WATER DEWATERING WORK PLAN
NAVAJO GENERATING STATION
PAGE, ARIZONA

Updated January 2015

1.0 Introduction

This Work Plan was prepared by SRP for the Navajo Generating Station (NGS) facility, located near Page, Arizona. SRP is undertaking mitigation activities to remove shallow (less than 70 feet) perched water that has formed beneath the plant site area. The purpose of this Work Plan, which is part of the comprehensive GWPP program, is to ensure that aquifer water quality is not impacted in the deep (~900 feet) regional Navajo Sandstone aquifer (SRP, 2014a,b).

2.0 Objectives

The objective of the perched water removal activities is to capture and control the migration of the perched water present beneath the NGS plant site area.

3.0 Approach

Perched water is extracted by pumping from the following wells/locations:

1) MW-65, located to the southeast of the Clarifying Tanks;
2) MW-73, located at the southeast corner of the Crystallizer Building;
3) NEX-3, located at the north end of Cooling Tower 1B;
4) MW-31R located at the south end of the Cooling Tower 2B;
5) MW-66, located approximately 150 feet west of the ash dewatering area; and
6) MW-27R, located at the south end of the Cooling Tower 1B.

Figure 1 shows the pump back locations. In addition, outfall from the 35-Pond French drain system is re-routed to the 35-6 Pond.

The pumped water is discharged back to plant process streams for reuse (Figure 2). The water pumped from MW-66 discharges to the Ash Ditch immediately south of the well site. The water pumped from MW-31R is discharged to the adjacent Cooling Tower basin 2B. The pumped water from MW-65 is discharged to the nearby lined drainage, which flows to the Acid Sump. The water pumped from MW-73 is discharged to the Crystallizer Sump. The water from NEX-3 and MW-27R is discharged to the Cooling Tower basin 1B. The wells generally pump at rates of less than 5 gallons per minute (gpm). The extraction wells will be pumped indefinitely for as long as perched water conditions remain at the Site.

Water levels are monitored semi-annually at the Carmel Unit monitor wells. Sampling is performed in accordance with the GWPP.

3.1 Extraction Well System Description

Table 1 provides a summary of the pertinent well information and equipment.

MW-31R

Well MW-31R was installed in October 2013 to a drilled depth of 36 feet and replaces MW-31. The well is constructed with four-inch diameter PVC casing to a depth of approximately 34 feet bgs. The well is screened from approximately 14 to 34 feet bgs. The depth to the bottom of the Carmel Unit in this area is approximately 34 feet. The depth to water was approximately 23 feet bgs in December 2013. (Note: the well casing of the original well MW-31 was damaged, which prevented installation of pumping equipment and so a replacement well, MW-31R, was installed in close proximity to the original well.)

MW-65

Well MW-65 was installed in 1985 to a drilled depth of 28 feet. The well is constructed with four-inch diameter PVC casing to a depth of approximately 27 feet bgs. The well is screened from 9 to 27 feet bgs. The depth to the bottom of the Carmel in this area occurs at approximately 30 feet bgs. The depth to water measured in November 2011 was approximately 6 feet bgs.

MW-66

Well MW-66 was installed in 1985 to a drilled depth of 28 feet. The well is constructed with four-inch diameter PVC casing to a depth of approximately 28 feet bgs. The well is screened from 17 to 28 feet bgs. Depth to the bottom of the Carmel in this area occurs at approximately 28 feet bgs. The depth to water measured in May 2007 was approximately 14 feet bgs. (Note: Start-up operations began in July 2007; the well has been operating since start up).

MW-73

MW-73 was installed in October 2013 to a drilled depth of 37 feet. The well is constructed with four inch diameter PVC casing to a depth of approximately 35 feet bgs. The well is screened from 15 to 35 feet bgs. The well was drilled to penetrate the entire thickness of the Carmel Formation, which is approximately 35 feet thick in this area.

NEX-3

NEX-3 was installed for the purpose of recovering fuel oil from an above ground pipeline leak that occurred at the Site during the mid-1980's, which since has been addressed (SRP, 2014). The well is constructed with 20-inch diameter Schedule 40 PVC slotted

casing to a depth of 16 feet bgs. The depth to the bottom of the Carmel in this area occurs at a depth of approximately 50 feet bgs. The depth to water measured on December 12, 2006 was approximately 9 feet bgs.

MW-27R

MW-27R was installed in December 2013 and replaces MW-27. MW-27R is constructed with four-inch diameter PVC casing to a depth of approximately 45 feet bgs. The well is screened from 5 feet to 45 feet bgs and penetrates the entire thickness of the Carmel Formation. The bottom of the Carmel occurs at a depth of approximately 45 feet in this area. The depth to water measured in April 2014 was approximately 36 feet bgs.

French Drain

The French Drain system underneath the 35-Pond is designed to capture water from beneath the pond. The discharge from the French Drain System will be piped to the 35-6 Pond.

3.2 PUMPING EQUIPMENT AND DISCHARGE ASSEMBLY

Each extraction well is fitted with a QED Environmental Systems Controllerless Pneumatic AutoPump, which cycles on and off depending on the water level in the well. The AutoPump requires only an air source for pump operation.

Each extraction well is fitted with an air supply hose; pump air exhaust hose, discharge hose, discharge check valve, and filter/regulator with pulse cycle counter.
Each well is outfitted such that it is isolated from the rest for sampling purposes and in the event that repairs are required. Discharge piping connections are as follows:

- For well MW-66, the well head discharge pipe is connected to the Ash Ditch via a discharge hose set on the ground surface.

- For MW-65, the well head discharge pipe is connected to the lined drainage connecting the Acid Sump.

- For MW-31R, the well head discharge pipe is connected to the Cooling Tower basin 2B.

- For MW-73, the well head discharge pipe is connected to the Crystallizer Sump trench.

- For NEX-3, the well head discharge pipe is connected to the Cooling Tower basin 1B.

- For MW-27R, the well head discharge pipe is connected to the Cooling Tower basin 1B.

3.3 Operation and Maintenance

Well site inspections will be conducted to ensure that the pumps are operating properly. Inspections will include but not be limited to checking the airline pressure, air compressor oil gauge, and visual inspections of the air and discharge lines. Inspections will be conducted weekly for the first four weeks of operation and then reduced to biweekly or monthly. An Inspection Logbook is filled out during each inspection.

The volume of water extracted from each well site is monitored and recorded by NGS personnel. To do this, the volume per cycle is measured using a graduated cylinder and the number of pumping cycles is recorded from the pulse cycle counter. The measured volume per cycle and the pulse cycle counter reading is documented in the Inspection Logbook during each inspection.

Failed pumps and other equipment is repaired and/or replaced as needed.

3.4 WATER LEVEL MONITORING

Water levels in the surrounding Carmel Unit plant site monitor wells will continue to be monitored semi-annually as part of the routine groundwater monitoring program (SRP 2014).

3.5 DISCHARGE SAMPLING

Discharge sampling is performed during start-up operations. The well discharge samples are collected for TDS, inorganics, arsenic, barium, cadmium, chromium, mercury, lead, and selenium analyses. The well discharge samples are collected at each well site prior to discharge to any receiving water.

4.0 Reporting

Information on pumping rates, extraction volumes, discharge water quality, and water levels in the Carmel Unit monitor wells is included in the Annual Site Groundwater Monitoring Report.

5.0 Roles and responsibilities

<u>Environmental Management Policy & Compliance</u>

- Provide oversight of the program and reporting of the data;
- Perform the pumping equipment installation and start up activities;
- Provide training and support to NGS personnel in the operation and maintenance of the pump back system. Training will focus on disassembling,

cleaning, and reassembling the pneumatic pumps. Typical maintenance activities include replacement of the check valve or cleaning of the float inside the pump to remove scale build-up.

Groundwater Resources and Geohydrology

- Provide technical support and oversight of the new monitor well installation activities

Civil and Structural Engineering

- Provide oversight of contractor activities related to the installation of the air and water piping, controls, and valves;
- Provide oversight of contractor activities related to the installation of the French Drain discharge piping.

NGS Personnel

- Oversee daily operations and conduct routine inspections and maintenance of the pumping equipment to ensure the integrity of pumping equipment and air supply;
- Report equipment failures to EMPC and submit the pumping records to EMPC on a quarterly basis;

6.0 References

SRP, 2014a. Navajo Generating Station: Groundwater Protection Plan.

SRP, 2014b. Groundwater Monitoring Program Report, 1978-Present, Navajo Generating Station, Page, Arizona.

Table 1. Summary of Pump Back Well Details, Materials, and Support.

PUMP BACK LOCATION	MW-65	MW-73	NEX-3	MW-31R	MW-66	MW-27R
DESCRIPTION	Existing Well	Existing Well	Existing Well	Replacement Well for MW-31	Existing Well	Replacement Well for MW-27
APPROX. TOTAL DEPTH FEET, BGS	28	37	16	36	28	45
APPROX. SCREEN INTERVAL FEET, BGS	9-27	15-35	0-16	14-34	17-28	5-45
APPROX. PAGE/NAVAJO CONTACT, FEET, BGS	30	35	40-50	34	30	45
WELL DIAMETER (IN)	4	4	20	4	4	4
WELL CASING	PVC	PVC	Schedule 40 Slotted	PVC	PVC	PVC
PUMP TYPE	QED Short AP4 Bottom Loading Auto Pump	QED Short AP4 Bottom Loading Auto Pump	QED Short AP4 Bottom Loading Auto Pump	QED Short AP2 Bottom Loading Auto Pump	QED Short AP4 Bottom Loading Auto Pump	QED Short AP4 Bottom Loading Auto Pump
AIR SOURCE	Plant air	Plant air	Air Compressor	Plant Air	Plant Air	Plant Air
DISCHARGE LOCATION	Lined Drainage ditch to S-13 Pond	Crystallizer Sump	CT 1B	CT 2B	Ash Ditch	CT1B
NGS/ENG. SUPPORT NEEDED	Discharge Piping to Drainage: 84 ft	Airline to Well	Discharge Piping to CT 1B: 220 ft; Electric Line: 120 ft	Blue Stake	None	

Figure 1. Well Pump Back Location Map.

Figure 2. Well Pump Back Discharge Locations.

APPENDIX 2: NAVAJO GENERATING STATION GROUNDWATER MONITORING PROGRAM, 1978 – PRESENT

Navajo Generating Station Groundwater Monitoring Program Report 1978-Present

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Prepared by SRP

January 30, 2015

Table of Contents

Tables

Figures

Attachments

GROUNDWATER MONITORING PROGRAM REPORT

1978-PRESENT

NAVAJO GENERATING STATION

PAGE, ARIZONA

January 2015

EXECUTIVE SUMMARY

Salt River Project (SRP) has been conducting on-going groundwater and seepage monitoring at the Navajo Generating Station (NGS) facility since plant operations began in the mid-1970s except for a short interruption in the early to mid-1990s. The purpose of the monitoring program coupled with the Groundwater Protection Plan (GWPP) and Perched Water Dewatering Plan is to ensure that the groundwater quality in the underlying deep Navajo Aquifer ("N Aquifer") is protected and not impacted by plant water seepage. The program is designed to monitor the regional N Aquifer at three (3) deep wells ("DW-1, 2, 3"); monitor shallow perched water zones that have formed beneath the plant site in the Carmel Formation; and monitor moisture conditions in the unsaturated zone above the N-aquifer using neutron logging. Constituents of concern include total dissolved solids (TDS), sulfate, and trace metals[1].

The Navajo Sandstone is the principle water bearing unit in the region. Groundwater occurs in this unit under unconfined conditions at a depth of approximately 900 feet beneath the NGS facility. Water levels in the three deep wells have been increasing at a rate of 1 to 2 feet per year likely due to recharge from Lake Powell, located approximately 2 miles north and northeast of the facility. The water level rise is

[1] Plant process water constituents are those found in the lake water used for cooling and that are concentrated during the plant cooling processes.

expected to continue over the next several decades until hydraulic equilibrium is reached. In the early years of plant operation groundwater flowed to the north-northwest but has gradually shifted to the west-southwest as a result of recharge from Lake Powell. As of 2003, there were no water supply wells that pump from the N Aquifer in the surrounding NGS area (US EPA 2003a) likely due to the high cost of installing and operating wells at that depth and given the availability of Lake Powell water resources. Water supply for the town of Page and the community of LeChee consists of surface water piped from Lake Powell.

The N Aquifer contains calcium bicarbonate type water with low levels of TDS (100 to 160 mg/l). The concentrations of trace metals, including arsenic, barium, cadmium, chromium, lead, and selenium are less than EPA Maximum Contaminant Levels (MCLs). In the 40 year operating history at NGS, there is no evidence of a long-term increasing trend in TDS in the groundwater samples from the deep wells due to either plant operations or recharge from Lake Powell. A temporary spike in TDS levels in DW-2 in the late 1980s was caused by a well construction issue that resulted in a temporary short-circuiting of perched water to the regional groundwater system. This well was subsequently cased and the TDS levels returned to background conditions.

Changes in groundwater quality in the N Aquifer, including increased TDS, may occur in the future as a result of recharge from Lake Powell. The potential changes are expected to lag the observed hydraulic water level response. The timeframe for potential impact will depend on the degree of fracture flow through the Navajo Sandstone. Although some fracture flow was indicated at DW-2, there is no evidence of extensive fracture flow throughout the Navajo Sandstone below the site.

The Carmel Formation forms a thin veneer overlying the Page Sandstone and Navajo Sandstone, capping many of the mesas in the area. It occurs at the surface in the immediate vicinity of the plant site. A shallow (less than 70 feet) perched water zone

has formed in the low permeability sediments of this formation. The perched water contains elevated levels of TDS and certain trace metals indicative of plant process water. Sampling results show that levels of metals for all wells sampled were substantially below limits considered hazardous as defined by the Resource Conservation and Recovery Act. Potential sources of the perched water include past seepage from the evaporation ponds, cooling towers, and previously unlined drainage ditches in the ash dewatering area.

NGS implemented a program (see Groundwater Protection Plan or GWPP) and specific remedial projects to address the sources of the perched water. In 2007, NGS initiated a perched water de-watering program to capture and control possible migration of water in the Carmel Formation. Additional pump back wells were added in 2013. The program involves pumping from several of the shallow wells back to plant processes for recycling. The water management and groundwater monitoring activities at NGS are in accordance with the GWPP.

In regards to evaluating the potential impact of plant operations to groundwater, neutron logging data from 1980 for DW-1 was used to determine the moisture profile and available retention capacity of the Page/Navajo Sandstone. The results indicate the sandstone below the plant site to a depth of approximately 480 feet has available retention capacity. The most recent (1997) neutron logging data show that moisture conditions in the upper 480 feet of the Page/Navajo Sandstone has not changed significantly since the initial logging in 1980, though a moisture front at the top of the Page/Navajo Sandstone has developed that was not present in 1980. The findings suggest that the Carmel Formation is effective in retarding the vertical migration of fluids and that there is no imminent risk of impacting the underlying N- Aquifer.

In the Ash Disposal Landfill area, neutron logging data (1997) for DW-3 suggests there has been a slight increase in the average moisture content of the upper 480 feet of the

Page/Navajo Sandstone beneath the landfill. This increase may account for the estimated volume of plant process water applied to the Ash Disposal Landfill for dust suppression activities in the late 1970s to early 1980s. An assessment of the Page/Navajo Sandstone's ability to retain moisture suggests that the historic application of plant process water to this area would be retained in the upper section of the Page/Navajo Sandstone.

Recent 2014 boring analyses of the original layers of fly ash and bottom ash that were placed as engineered fill and compacted indicate this bottom layer of ash deposit is impermeable (boring refusal was encountered) and has the strength of a lean concrete. No further additional remedial actions for the Ash Disposal Landfill are recommended at this time. Groundwater monitoring going forward will be in the accordance with the GWPP.

This report summarizes the hydrogeology of the area surrounding NGS, the history of groundwater and seepage monitoring, water management practices, and ongoing remediation steps to remove shallow perched water in the Carmel formation beneath the plant site. Based on the hydrogeological conditions, long-term monitoring data, and plant operation protective measures, no impacts to the regional N Aquifer are anticipated due to past, current, or future operations. SRP will continue to monitor water levels and water quality in the shallow perched water and deep groundwater, and implement inspections and remediation plans as described in the GWPP.

1.0 INTRODUCTION

This report presents a summary of the groundwater and seepage monitoring conducted by the Salt River Project Agricultural and Improvement District (SRP) historically from 1978-present at the coal-fired Navajo Generating Station (NGS) facility, located near Page, Arizona (Figure 1). Groundwater and seepage monitoring is conducted at the facility in accordance with provisions listed in a Memorandum to SRP from the United States Bureau of Reclamation (USBR) concerning the designs and plans of NGS facilities (USBR, 1973). The provisions require the installation of monitoring equipment to assure protection of the environment. Constituents of concern at the facility include total dissolved solids (TDS), sulfate, and certain trace metals. Groundwater monitoring activities are conducted in accordance with the 2014 NGS Groundwater Protection Plan (GWPP).

This report includes an overview of the project history, description of the hydrogeological conditions, water management practices, and provides a summary assessment of existing data. The information in this report is intended for use as part of the GWPP.

2.0 PROJECT HISTORY

SRP, the operator of NGS, assumed full responsibility for the groundwater monitoring program in 1978. Prior to that, both Bechtel and SRP were involved. Bechtel Corp., the original NGS design-build contractor, installed the first seepage wells during construction and startup activities between 1973 and 1975. Shallow perched water was encountered in the Carmel Formation underlying the plant site in the early operations and SRP significantly expanded the monitoring program in 1978, installing additional shallow seepage wells near the evaporation ponds, drainage ditches, cooling towers,

and power block. Shallow monitoring wells were also installed at the west end of the Ash Disposal Landfill. In addition, a network of neutron logging wells was drilled to monitor subsurface moisture content in the sandstone units beneath the Carmel Formation in the plant site area and beneath the Ash Disposal Landfill. Further, three deep wells were installed to monitor the deep N Aquifer water quality beneath the facility. Figure 2 presents a graphical timeline of events related to the historical operations and monitoring program at NGS.

The monitoring program is designed to:

- Monitor groundwater levels and water quality of the deep (~900 feet) regional unconfined N Aquifer beneath the facility;
- Monitor shallow perched water zones observed in the relatively thin (~10-70 feet thick) Carmel Formation overlying the Page/Navajo Sandstone beneath the plant site, and
- Monitor moisture conditions in the upper unsaturated Page/Navajo Sandstone in the plant site and Ash Disposal Landfill.

A total of 78 monitor wells, including three (3) deep wells, 58 shallow wells, and 17 neutron wells (for measuring moisture content) were constructed. Over time, some have been displaced due to plant re-construction activities and are no longer active; some were modified and/or abandoned to prevent vertical conduit issues. Tables 1 and 2 provide construction details for all monitor and neutron logging wells. Figures 3 and 4 are well location maps for the plant site and Ash Disposal Landfill, respectively. Attachment 1 provides general well construction diagrams. The wells are described in more detail below.

Deep Monitor Wells

There are three deep monitor wells (DW-1, DW-2, and DW-3) at NGS that monitor deep groundwater conditions in the regional N-aquifer. They are

located near the 60-2 Evaporation Pond at the north end of the plant site (DW-1); in the railroad loop of the plant site (DW-2); and at the northwest area of the Ash Disposal Landfill (DW-3). DW-1 was installed in 1979 to a total depth of 1200 feet bgs. Both DW-2 and DW-3 were drilled in 1981 to total depths of 1500 feet bgs. Original construction of all three wells included 8 inch diameter steel surface casing to depths ranging from 20 to 80 feet below ground surface (bgs), with an approximate 6 inch diameter open borehole from the bottom of the surface casing to total depth. The purpose of the surface casing was to prevent potential migration of plant process water from the Carmel Formation into the underlying groundwater. However, DW-2 was cased in 1989 after SRP discovered water entering the open borehole below the surface casing via a fracture at 125 feet and short-circuiting to the groundwater, causing a spike in TDS levels. The DW-2 casing liner extends to a depth of 660 feet; the borehole is open from 660 feet to 1500 feet. DW-1 was cased in 2008 to prevent any potential vertical conduit issues. The DW-1 casing liner extends to a depth of 700 feet; the borehole is open from 700 feet to 1200 feet. SRP is planning to install a casing liner in DW-3 during 2015.

Shallow Monitor Wells

A total of 58 shallow monitor wells were drilled up to depths of approximately 70 feet bgs in the plant site and Ash Disposal Landfill to detect possible seepage. These shallow monitor wells were constructed with 2 to 4 inch PVC casing screened at varying intervals across the Carmel and upper Page/Navajo Sandstone. Of the 58 wells, 28 were screened across the Carmel Formation, 15 were screened across the Carmel and upper Page/Navajo Sandstone, and 9 were screened across the upper Page/Navajo Sandstone. As mentioned, several of the original shallow wells are now inactive for various reasons. In addition to the shallow seepage monitor wells, three recovery wells were installed north of the

Unit 1B Cooling Tower in the mid-1990s to address a fuel oil leak[2]. In 2013, due to well construction and potential vertical conduit issues, SRP abandoned or replaced 11 wells that penetrated the upper Page/Navajo Sandstone.

Neutron Wells

Sixteen neutron wells were installed in 1978 for purposes of monitoring subsurface moisture conditions in the upper unsaturated Page/Navajo Sandstone beneath the plant site and Ash Disposal Landfill. The wells were constructed with 2.5 inch steel casing to depths of 44 feet to 149 feet. One additional neutron well, located in the Ash Disposal Landfill, was installed in 1997 to a depth of 440 feet bgs and constructed with 4 inch steel casing. The neutron wells have since been displaced. The three deep wells were also used historically for neutron logging purposes.

In 2002, the Navajo Nation Superfund Program (NSP) in conjunction with the Environmental Protection Agency (EPA) conducted a Site Investigation of the NGS facility as part of a nationwide survey and in response to reported environmental discharges (bearing cooler water and fuel oil) at the facility. The purpose of the investigation was to determine the level of trace metals and organics in the perched water and level of metals in the washes near the facility. A preliminary assessment of the facility had been conducted earlier in 1993. During the 2002 Site Investigation, NSP/EPA sampled three of the shallow monitor wells (MW-6, MW-21, and MW-63) and collected soil samples from the unnamed wash east and north of the facility to the confluence with Antelope Canyon. Based on the results of the investigation, NSP/EPA determined that NGS did not qualify for Superfund listing and that no further assessment was warranted at the facility (EPA 2003).

[2] An underground fuel line leak occurred in the mid-1990's and approximately 31,550 gallons of fuel oil was recovered. In 1996, SRP sampled for petroleum hydrocarbons in response to the leak. Results are presented in Section 5.0.

3.0 GEOLOGY/HYDROGEOLOGY

3.1 Geology

NGS is located within the southwestern region of the Colorado Plateau Physiographic Province. Within the facility area, the land surface is characterized by flat lying sedimentary rocks that have eroded to form mesas and deep canyons. The land surface elevation is approximately 4300 feet above mean sea level.

The geologic units exposed on and in the vicinity of the plant in ascending order include: the Triassic-Jurassic age Navajo Sandstone; the Jurassic Page Sandstone and Carmel Formation; and recent age Dune Sand. The Navajo Sandstone is the predominant geologic unit on a regional scale and is exposed in the canyons and mesas in the area around the facility. The unit is approximately 1400 feet thick in the facility area and the three NGS deep wells likely penetrate nearly the entire formation. Previously, the Page Sandstone was considered part of the Navajo Sandstone. However, the Navajo Sandstone is separated from the Page Sandstone and Carmel Formations by a regional unconformity termed the J-2 unconformity (USGS, 1978). According to the USGS report, the Page Sandstone is approximately 180 feet thick at a location two miles north of the facility; the sandstone unit pinches out several miles east and southeast of Page (and the NGS facility). It is important to note that the driller's logs for the NGS monitor wells do not differentiate the Page Sandstone from the Navajo Sandstone. However, the contact between the Navajo Sandstone and Page Sandstone may exert influence on potential migration of fluids through the subsurface. The report herein refers to the two sandstone formations as 'Page/Navajo Sandstone'.

The Page/Navajo Sandstone outcrops in the eastern area of the plant site and the Solid Waste Landfill and NE-1 Series Ponds are situated on the sandstone. The Ash Disposal Landfill east of the plant site also is situated on the Page/Navajo Sandstone.

The Carmel Formation caps many of the mesas occurring in the region surrounding the facility and a relatively thin layer (up to 70 feet) of the Carmel Formation exists locally beneath the plant site. Dune Sand occurs as a surficial, thin veneer, primarily in the eastern area of the plant site and in the Ash Disposal Landfill. Figure 5 is a schematic showing the relation of the geologic units in the NGS area from Navajo Canyon east of the facility to Glen Canyon Dam west of the facility. A brief description of each unit is given below.

Dune Sand

The Dune Sand consists of red-brown to buff, silty fine to medium sand up to 15 feet thick. This unit is loose and unconsolidated consisting primarily of rounded to subangular quartz and minor amounts of feldspar. The Dune Sand deposits are estimated to have a permeability ranging from approximately 900 to 1700 feet per year.

Carmel Formation

The Carmel Formation within the plant site area consists of reddish brown to gray interbedded silty sandstone, siltstone, and claystone. According to SHB (1975), fractures occur in the Carmel Formation but are limited in vertical extent and generally occur in only one rock type. In addition, some of the fractures have been cemented with secondary minerals. The Carmel Formation thickness ranges from only a few feet near the Unit 3 Cooling Tower area at the south end of the plant site up to approximately 70 feet beneath the evaporation ponds at the northern end of the facility. The permeability of the Carmel Formation is estimated to range from less than one foot per year to as high as 90 feet per year, with the higher rate occurring in areas were fracturing exists (SHB, 1975). Where the Carmel Formation has been disturbed by plant construction activities, the formation may have increased permeability.

Page Sandstone and Navajo Sandstone

According to the USGS report (1978), the Page Sandstone at the locality north of the plant site is a moderate-reddish-brown, moderate-reddish-orange, and locally very light gray or grayish-pink cross-bedded fine-grained well sorted sandstone. The basal contact of the Page Sandstone includes a relatively thin layer of chert pebbles.

The Navajo Sandstone consists of buff to light brown, fine to medium grained sandstone that is approximately 1400 feet thick in the facility area. This unit is cross-bedded, massive, and moderately cemented.

The primary permeability of the Page/Navajo Sandstone is estimated to range from 10 to 400 feet per year, with an average of 200 feet per year. The ability of the formation to retain water in the unsaturated zone depends on its porosity, specific retention capacity, and moisture content. Hydrologic properties of the Page/Navajo Sandstone as determined by SRP are summarized below.

Parameter	***Range***
Porosity	20-28%
Specific Retention	10-13%
Percent Moisture (unsaturated Zone)	7-16%
Saturated Hydraulic Conductivity (cm/sec)	9.7×10^{-6} to 3.9×10^{-4}

SRP determined from the 1980 neutron logging data that the percent moisture increases with depth. Above 480 feet bgs, the percent moisture was less than the specific retention capacity of the formation, meaning that any plant process water that potentially migrated into the formation above that depth would be retained or held in

suspension in the unsaturated zone until the percent moisture reaches the specific retention level. However, below this depth, percent moisture was either equal to or exceeds the specific retention capacity of the formation. Therefore, below 480 feet bgs, plant process water migration would be governed by the unsaturated permeability of the formation and eventually primary permeability assuming water migration continues.

Major structural features are absent in the plant area. Geologic strata are nearly horizontal, with maximum localized dips up to only a few degrees in varying directions. SRP in the early 1980's conducted a field reconnaissance to characterize the extent and magnitude of fractures in the Page/Navajo Sandstone as the fractures may influence migration of fluids through the subsurface. However, data is limited on the depth of and connectivity of the fractures. The Navajo Sandstone is the principal water bearing unit in the region. Average depth to water under the NGS is approximately 900 feet bgs. As of 2003, there were no water supply wells that pump from the N Aquifer in the surrounding NGS area (US EPA 2003a) likely due to the high cost of developing and operating wells at that depth and water available from Lake Powell. The water supply for the town of Page and the community of LeChee consists of surface water piped from Lake Powell.

3.2 Hydrogeology

Routine water level measurements of the monitor wells were conducted on a monthly or quarterly basis during the early period of operation (1978-1987). Since the mid-1990s, measurements have been made semi-annually. Measurements were made with either steel tapes or electric sounder.

Groundwater in the Navajo Sandstone is under unconfined conditions in the NGS area and makes up the N Aquifer. The N Aquifer is the principal aquifer unit in the region. Based on routine water level measurements for the three deep wells, DW-1, DW-2, and

DW-3, depth to groundwater in the Ash Disposal Landfill area was approximately 940 feet bgs in November 2012; depth to groundwater in the plant site area ranged from approximately 860 feet to 928 feet in November 2012 (Table 3). Groundwater level elevations in November 2012 ranged from 3,456 feet to 3,504 feet, above mean sea level in the plant site area and Ash Disposal Landfill area, respectively.

Hydrographs for the three deep wells show that water levels have increased a total of 40 to 80 feet since the early 1980's, representing a rate of one to two feet per year (Figures 6a and b). The rise is likely due to recharge from Lake Powell and is expected to continue. USBR predicted that groundwater levels will rise to an elevation of approximately 3,550 to 3,600 feet above mean sea level beneath the NGS facility in response to the Lake Powell recharge (USBR, 1969). Assuming that the observed water level rise is due to the lake recharge, then, using a rate of rise of one to two feet per year, hydraulic equilibrium would be reached in the next 50 to 100 years based on the earlier predictions. This rise is important in evaluating impacts of plant seepage on the aquifer as the distance for potential plant process water migration to reach the N-Aquifer is reduced.

Figures 7a, 7b, and 7c present groundwater elevation maps for the deep wells for December, 1981, November 1998, and November 2012, respectively. Based on the recent water level data, the current groundwater flow direction is toward the west / southwest; the hydraulic gradient is approximately 0.007. Based on the historical water level data, the groundwater flow direction has been gradually shifting from the north/northwest. This shift appears to be related to the effects of recharge occurring from nearby Lake Powell which began filling in 1963 and reached full pool in 1980.

Based on the historical water level monitoring data for the shallow wells, a perched water zone has formed in the Carmel Formation beneath the plant site. The perched water conditions occur as water infiltrates from the surface and is intercepted by the

lower permeability sediments of the Carmel Formation. Based on the data, water is present in many of the Carmel monitor wells, indicating the formation is partially saturated. According to earlier reports, water was not encountered in the Carmel sediments during plant siting studies. Figure 8 shows the extent of the perched water.

Table 3 provides the depth to water readings for the shallow wells for November 2012. The depth to water in the Carmel wells at that time varied from approximately 7 feet bgs in the central plant site area to more than 20 feet bgs in the northern plant site area. Figure 9a-c present hydrographs for select monitoring wells. In general, the data show that water levels in the Carmel wells in the northern plant area are dissipating (near the 60-2 ponds, which have been lined). Water levels in the central plant site area wells have remained relatively steady. Water levels in the Unit 2 cooling tower area wells show an increasing trend. The probable causes are discussed in Section 4.2.

Based on the water level data, the Carmel Formation has very poor hydraulic connectivity and a water level elevation map for the entire area is not feasible. Consistent with the formation characteristics reported in Section 3.1, the Carmel is hydrologically tight. Consequently, many of the wells are typically bailed or pumped dry during sampling events. However, some wells can sustain low pumping rates (generally less 5 gpm) indicating higher permeability zones. An estimate of the amount of water stored in the Carmel Formation is problematic due to the secondary permeability associated with fracturing of the formation.

Most of the shallow monitor wells screened across the upper unsaturated Page/Navajo Sandstone were historically dry. In 2013, NGS properly closed and abandoned 11 of these wells to prevent the possibility of vertical conduit issues.

4.0 Plant Process Water Management Practices

NGS was designed with cooling towers as a zero-discharge facility, meaning that water brought onto the plant site would not be released other than in the form of evaporation. Water captured from cooling tower blowdown, storm water run-off from developed areas of the facility, and other plant processes are recovered and recycled through a series of storage ponds, evaporation ponds and water treatment facilities.

The initial plant design utilized a series of shallow evaporation ponds and low capacity brine concentrator to process plant water. Today the facility uses three brine concentrators and a crystallizer to recover and recycle water from plant processes. The solid material that accumulates during the treatment process is disposed in salt disposal cells that are double lined with leachate recovery systems..

Seepage from plant processes has over time created a shallow perched water zone in the Carmel Formation (Figure 5). SRP has implemented corrective actions to mitigate and/or eliminate potential sources of the seepage and potential for this perched water to migrate vertically to the Page/Navajo Sandstone formations below. In addition, historically, some plant process water was used for dust suppression activities in the Ash Disposal Landfill area between the late 1970's to mid-1980's at a time when there was insufficient pond storage capacity and before the facility's brine concentrators were fully operational. The potential sources of plant seepage and application of plant process water in the Ash Disposal Landfill area are described further below.

4.1 Ash Disposal Landfill

The Ash Disposal Landfill lies approximately one mile east of the NGS facility on 765 acres of leased land. The landfill was constructed in the early 1970s against the edge of

a mesa outcrop in the Page/Navajo Sandstone. The disposal capacity is approximately 38 million cubic yards of dry materials such as fly ash, economizer ash, bottom ash, and dewatered flue gas desulfurization (FGD) gypsum (i.e., calcium sulfate).

The sandstone bedrock serves as the base of the Ash Disposal Landfill along with the original layers of fly ash and bottom ash, which were placed as engineered fill and compacted with a sheep's foot vibrating compactor at optimum moisture. Recent boring analyses indicate those original layers are the strength of lean concrete, providing a barrier to the aquifer which currently lies approximately 900 feet below.

Ash material is deposited in horizontal terraces against the steep vertical walls of the sandstone outcrop. Supplemental water and other measures are used to compact the materials to control fugitive dust emissions. The western edge of the embankment is constructed as a series of small terraced fills to contain storm water run-off within the ash disposal embankment. The combination of the dry disposal of this material in a dry climate with a high evaporation rate reduces the mobility and leachability of these coal ash and FGD constituents.

According to plant records and/or communication with NGS personnel and as previously provided to EPA as part of the 2001-2002 Site Investigation, there were two primary applications of plant process water to the Ash Disposal Landfill area:

1) Dust Suppression – Initial plant design included low capacity brine concentrators and evaporation ponds for storage of plant process water. However, during the early operations, more process water was generated than could be evaporated and when pond storage capacity was exceeded. The additional plant process water was piped to the ash landfill and used to supplement fugitive dust suppression activities. This occurred from 1978-1981. According to plant personnel, the estimated volume of water applied to the ash area during this period was approximately 60 to 140 gallons per minute or about 390 to 900 AF.

Substantial upgrades in brine concentrator capacity were completed in 1980 and 1986 and a salt crystallizer was installed in 1987. These upgrades substantially improved water management at the facility, reduced the need for shallow evaporation ponds, and allowed all process water to be captured, recycled, and managed within the holding ponds.

2) Draining of NE-1 Pond - Records show that approximately 205 AF of plant process water was applied to the Ash Disposal Landfill as supplemental dust suppression during the reconstruction of the NE-1 pond in 1985.

4.2 Plant Site

With respect to the plant site, seepage has caused a perched water zone to form in the Carmel Formation. A review of monitoring data, plant records, and communication with NGS personnel identified three potential sources:

1) Evaporation Ponds - The original design for the ponds took advantage of the site's natural characteristics (geology) and the relatively low permeability of the Carmel Formation. All ponds have since been equipped with impermeable liners. Since this work has been completed, the data show that water levels in the Carmel in the northern plant area are dissipating. Attachment 2 provides an overview of the pond lining history. A reasonable estimate of the amount of water leaked to the subsurface cannot be made based on the existing data.
2) Cooling Towers - Perched water observed around the cooling towers is believed to be associated with a combination of factors, including leakage from the unit cooling tower basins, infiltration of surface water leaks and overflows, and infiltration of ponded cooling tower drift combined with natural precipitation. The cooling tower basins and recirculation system piping are routinely inspected and repaired during scheduled plant outages to minimize leakage, and catch

basins were installed in DATE to capture overflow. A reasonable estimate of the amount leaked to the subsurface cannot be made based on the existing data.

3) Unlined drainage ditches– Prior to 1990, the drainage ditches were unlined. In 1990, the ditches were lined with concrete. An estimate of the amount of water leaked from the drainage ditches prior to 1990 cannot reasonably be made based on the available data. The water level data indicate there may be on-going sources in this area, which is being addressed, and mitigated as necessary, as part of the implementation of the GWPP.

5.0 Summary of Historical Monitoring Data

This section provides a summary of the historical water quality sampling data and neutron data collected for the network of NGS monitor wells. The water quality monitoring data are stored in a database managed by SRP.

5.1 Water Quality Sampling Results

5.1.1 Deep Wells

Routine water quality sampling of the deep wells was conducted on a monthly or quarterly basis during the early period of operation (1978-1987). Samples were obtained using the bailer method and analyzed for major ions and TDS. Since the mid-1990s, water samples have been collected semi-annually for major ions and TDS. In addition, since 2011, water samples have been collected annually for metals. Samples are obtained using the bailer method, except that from approximately the mid to late 1990s, DW-1 and DW-3 were purged prior to sampling. Routine water samples are submitted to SRP's state certified laboratory in Phoenix.

The ambient or background water quality of the N Aquifer was established based on samples obtained from the deep wells in 1979 and 1981. Groundwater in the deep N Aquifer is of excellent quality. The analytical results of these samples indicate the

native chemical character of the groundwater is predominantly calcium bicarbonate, with TDS levels ranging from 100 mg/l to 160 mg/l and sulfate levels ranging from 10 mg/l to 40 mg/l. Concentrations of nitrate as nitrogen and fluoride are relatively low and less than the EPA Maximum Contaminant Levels or MCLs of 10 mg/l and 4 mg/l, respectively. Nitrate levels are generally less than 3 mg/l; fluoride levels are generally less than 1 mg/l. Concentrations of metals, including arsenic, barium, cadmium, chromium, lead, and selenium are less than the MCLs (Table 4). As with water levels, the overall TDS of the regional aquifer is expected to rise as hydraulic equilibrium is reached with Lake Powell, which is sodium-calcium sulfate type water with TDS level in the range of 400 to 700 mg/l. However, the TDS rise will lag the recharge water level rise.

Figures 10-13 show the variations in TDS and sulfate concentrations in the three deep wells over the last three decades. The data show that with the exception of the temporary spike in TDS and sulfate in DW-2 as described earlier, levels of TDS and sulfate in the monitor wells have remained relatively constant and at background levels over the last 35 year monitoring period. Since the well was cased in 1989, TDS and sulfate levels promptly returned to background levels as evidenced by the data in Figure 12.

5.1.2 Shallow Wells

Routine water quality sampling of the shallow wells was conducted on a monthly or quarterly basis during the early period of operation (1978-1987). Samples were obtained using the bailer method and analyzed for major ions and TDS. Since then, water quality sampling has been conducted only periodically as the chemical character of the plant process water has not changed significantly over time.

In 1996, select shallow wells were sampled for metals and for hydrocarbons. Additional hydrocarbon sampling was performed in 1998. During the 1996 and 1998 sampling events, the shallow wells were first purged of up to three casing volumes or pumped dry and allowed to at least partially recover prior to sampling. Water samples are submitted to SRP's state certified laboratory in Phoenix.

Based on the historical data, the chemical character of the perched water in the Carmel Formation beneath the plant site is predominantly sodium sulfate type water with TDS and sulfate concentrations that range over three orders of magnitude, depending on well location (Figures 13-14). In general, the lowest TDS levels (~1,000-8,000 mg/l) are found in well samples from the central power block area. TDS levels in wells near the cooling towers are on the order of 10,000 mg/l. The highest TDS concentrations (~100,000 mg/l) have been observed in samples from wells located near the evaporation ponds in the northern plant area. Sulfate levels in shallow well samples have ranged typically between 1,000 mg/l to 10,000 mg/l. The observed TDS and sulfate levels are characteristic of the plant process water. For example, the least processed water is in the central power block. The more highly processed water is found in the evaporation ponds in the northern plant area.

The analytical results for 1996 show that levels of metals for all wells sampled were substantially below limits considered hazardous as defined by the Resource Conservation and Recovery Act (Table 5). The results are consistent with the 1992 Brown and Caldwell sampling performed on behalf of SRP (SRP, 1992) and the 2002 EPA findings (EPA, 2003).

Table 6 summarizes the analytical results for 1996 and 1998 fuel hydrocarbon sampling events. The greatest TPH concentration was detected in 1996 at well NA- 64, with a level of 37 mg/l. TPH concentrations measured in 1998 ranged from less than 0.1 mg/l to 7.7 mg/l, with 7 of the 8 samples containing less than 1 mg/l. In addition,

concentrations of benzene, toluene, and xylenes measured in the 1998 samples were less than the method detection limit of 0.5 mg/l.

5.2 Moisture Conditions in the Unsaturated Zone

Geophysical logging for moisture content has been intermittent, in the early 1980's and most recently in 1997. During the 1997 logging event, SRP also conducted video surveys of DW-1 and DW-3. Attachment 3 provides the deep well neutron logging data.

5.2.1 Ash Disposal Landfill

An evaluation of the potential groundwater impacts due to application of water to the Ash Disposal Landfill was performed assuming the entire estimated volume of water applied in this area was lost due to infiltration into the Page/Navajo Sandstone. The available retention volume for the upper 480 feet of the sandstone was calculated assuming an impact area of 160 acres, only porous media flow through the Page/Navajo Sandstone (no fracture flow) and no lateral spreading, and using the following hydraulic properties for the Page/Navajo Sandstone: 1) a specific retention of 12 percent; 2) an average moisture content of 8.5 percent based on neutron logging data obtained for DW-1 in 1980. Based on these calculations, the estimated available retention capacity in the upper 480 feet of sandstone for the 160 acre area is approximately 2,700 AF. This volume is greater than the estimated volume (1,105 AF) applied to this area, suggesting the potential infiltration due to the past activities would be retained within the upper 480 feet of the sandstone units.

The above evaluation uses the conservative assumption that all of the water applied infiltrated directly into Page/Navajo sandstone. A certain percentage of the water likely would have been absorbed by the coal ash and/or lost to evaporation

During the more recent 1997 neutron logging at DW-1 and DW-3, SRP determined that the average moisture content in the upper 480 feet of the Page/Navajo Sandstone formation at DW-3 was 10 percent, which was slightly higher than the 8.5 percent estimated for DW-1. This reduced retention volume is approximately 1,200 AF and may account for the water applied to this area in the early 1980's and/or natural recharge processes associated with the surrounding higher terrain in the Ash Disposal Landfill area. The remaining retention capacity for this area is approximately 1,500 AF.

The average moisture content in the upper 480 feet at DW-3 is based on the neutron logging and video survey data obtained from that well in 1997. The neutron data indicated relatively high moisture conditions in the unsaturated zone and in fact the neutron counter was overwhelmed at a depth of 569 feet. Inspection of the video survey showed water seeping into the open borehole at a corresponding depth and existing or re-entering the sandstone at a depth of 750 feet. Using 569 feet as the saturation point having moisture content of 12 percent, a calibration curve was constructed between moisture content and API counts. From this, the average moisture content in the upper 480 feet was then determined.

The moisture at 569 feet may have been there previously (i.e. naturally occurring), however, there are no previous neutron data for comparison purposes. The water entering the borehole was sampled. The analytical results showed the water is predominantly calcium chloride type water and are not conclusive as to the source of the water.

In addition, the early 1980's logging data showed increased moisture content at N-55 that extended to the maximum depth of the well (100 feet). N-72 was drilled in 1997 adjacent to N-55 to a depth of 445 feet. No saturated conditions were encountered during drilling. An attempt was made to obtain measurements of the absolute moisture

content of several soil cores. However, the resultant moisture content values were relatively low and likely not representative of in-situ moisture conditions.

Fractures are present in the Navajo Sandstone. However, the connectivity of the fracturing is not well known. As described, there is no evidence of groundwater impact based on the water quality data for DW-3.

5.2.2 Plant Site

In the plant site area, seepage of plant process water has created a perched water zone in the Carmel Formation overlying the Page/Navajo Sandstone. No information is available regarding the rates, volumes, and frequency of seepage to the subsurface. An evaluation of potential groundwater impacts was performed assuming only porous media flow and based on the moisture content profile for DW-1 as obtained from the neutron logging at the well in 1980 and most recently in 1997.

In 1980, SRP conducted neutron logging of DW-1 and determined the percent moisture content of the upper 480 feet of Page/Navajo Sandstone was less than the average specific retention capacity of 12 percent. For this evaluation, an average moisture content of approximately 8.5 percent was assumed.

Based on the more recent (1997) neutron logging conducted at DW-1 and DW-3, moisture conditions had not increased significantly at DW-1 since the initial logging in 1980. However, the neutron data for DW-1 indicated a moisture front has developed below the original surface casing (before the well was modified) at a depth of approximately 80 feet bgs that was not present in 1980. The seepage front appears limited to the upper 50 feet of the Page/Navajo Sandstone and is consistent with the decrease in perched water levels in the Carmel Formation in that area. These findings suggest that the Carmel Formation is effective in retarding the vertical migration of

fluids and that there is no imminent risk of impacting the deep underlying N Aquifer. Though limited, the seepage of plant process water will reduce the available retention capacity of the sandstone in those areas. An additional increase in moisture content occurred near a depth of 200 feet. This was observed in 1980 and appears unchanged.

The 1997 neutron logging data for DW-2 shows increased moisture conditions in the top 60 feet of the Page/Navajo Sandstone. This is above the depth where perched water was observed entering the open borehole (prior to casing). The neutron logging findings are consistent with those for DW-1.

In addition, the early logging data showed increased moisture conditions in the northeast area of the plant site. However, SRP determined that the elevated moisture could not be conclusively attributed to seepage of plant process water and may be a result of recharge runoff from the nearby unnamed wash or initial plant construction activities.

6.0 Evaluation of On-Going Sources

The existing water level data for the monitor wells in the Carmel Formation suggest that plant seepage may be on-going in two areas of the plant site. Additional assessment of the ash dewatering system and cooling towers is needed to identify the source of this water.

7.0 Summary of Groundwater Impacts

From the beginning of monitoring in 1979 to today, the deep wells in the plant site and Ash Disposal Landfill show no significant groundwater changes in TDS due either to plant operations or recharge from Lake Powell. There was a temporary spike in TDS in the

late 1980's due to well construction and a brief short-circuiting of perched water accumulated beneath the plant site in the Carmel Formation. Corrective actions taken at NGS to address potential source areas include upgrades to the pond liners, upgrades to linings in the drainage ditches of the ash dewatering area, and repairs to cooling tower basins. In addition, significant upgrades in brine concentrator capacity and addition of a salt crystallizer have improved overall waste management at NGS. Further, the perched water is being pumped from the Carmel Formation back to process streams for recycling, which is described further in the GWPP.

8.0 REFERENCES

Salt River Project, October 1992. Completion Report Environmental Site Assessment of the S-5 Surface Impoundment Navajo Generating Station Page, Arizona, Water and Waste Division, Environmental Service Department.

Salt River Project, September 2014a. Navajo Generating Station Groundwater Protection Plan.

Salt River Project 2014b. Navajo project description. Draft Submitted to Reclamation dated November 14, 2014.

Sergent, Hauskins, & Beckwith, SHB Job No. E75-11A Geotechnical Investigation Report Additional Evaporation Ponds On-Site Areas Navajo Generating Station, Units 1 2, &3 Page, Arizona.

U.S.B.R. Memorandum to the Salt River Project, dated February 20, 1973.

U.S.B.R., 1969, Bank Storage Lake Powell, Open File Report.

U.S. EPA, 2003a. Site Inspection Report, Navajo Generating Station, LeChee Chapter, Navajo Nation Page, Coconino County, Arizona, EPA ID No. NND98240024 prepared by Navajo Superfund Program Waste Regulatory Compliance Department Navajo Nation Environmental Protection Agency.

U.S. EPA, 2003b. Letter to SRP, dated August 14, 2003.

Tables

Table 1. Well Construction Details for NGS Monitor Wells.

Well ID	*Status*	*Latitude*	*Longitude*	*Altitude of Land Surface (ft msl)*	*Well Type*	*Original Drill Year*	*Drilled Depth (ft bgs)*	*Casing Diameter/Type*	*Casing Depth (ft bgs)*	*Depth to Top of Perforated Interval (ft bgs)*	*Depth to Bottom of Perforated Interval (ft bgs)*	*Formation Monitored*[a]	*Approx. Carmel/PN Contact (ft bgs)*
Active Wells													
MW-6	Active	N36°54.927'	W111°23.306'	4312.2	Monitor	11/1/1973	41	2" PVC	41	11	41	Carmel	---
MW-7R	Active	N36°54.870'	W111°23.182'	4310.9	Monitor	12/21/2013	41	4" PVC	36	5	36	Carmel	36
MW-19	Active	N36°54.731'	W111°23.145'	4315.5	Monitor	11/15/1973	20	2" PVC	20	10	18	Carmel	---
MW-21	Active	N36°54.984'	W111°23.738'	4290.3	Monitor	12/10/1975	27	4" PVC	27	26	27	Carmel	---
MW-23	Active			4316.4	Monitor	6/15/1978	23	3" Steel	10	10	23	Carmel	---
MW-27R	Active	N36°54.438'	W111°23.401'	4368.7	Monitor/Pump Back	12/20/2013	55	4" PVC	45	5	45	Carmel	45
MW-29B	Active	N36°54.524'	W111°23.454'	4369.3	Monitor	6/30/1978	25	.5" PVC	25	20	25	Carmel	---
MW-30	Active	N36°54.333'	W111°23.665'	4362.7	Monitor	7/3/1978	22	2" PVC	22	0	22	Carmel	---
MW-31R	Active	N36°54.375'	W111°23.591'	4363.5	Monitor/Pump Back	10/22/2013	36	4" PVC	34	14	34	Carmel	34
MW-32A	Active	N36°54.432'	W111°23.693'	4364.3	Monitor	6/28/1978	41	.5" PVC	12	0	12	Carmel	---
MW-32B	Active	N36°54.432'	W111°23.693'	4364.3	Monitor	6/28/1978	41	.5" PVC	25	22	25	Carmel	---
MW-33	Active	N36°54.452'	W111°23.632'	4364.1	Monitor	6/29/1978	10	4" PVC	10	0	10	Carmel	---
MW-40R	Active	N36°53.941'	W111°23.376'	4393.2	Monitor	12/17/2013	38	4" PVC	12	5	12	Carmel	12
MW-41R	Active	N36°53.982'	W111°23.268'	4391.0	Monitor	12/21/2013	21	4" PVC	11	5	11	Carmel	11
MW-42R	Active	N36°54.012'	W111°23.377'	4390.8	Monitor	12/16/2013	25	4" PVC	18	5	18	Carmel	18
MW-43	Active	N36°54.027'	W111°23.329'	4389.4	Monitor	7/14/1978	21	4" PVC	13	0	13	Carmel	16
MW-56	Active	N36°54.902'	W111°23.840'	4302.0	Monitor	8/19/1980	19	4" PVC	19	9	19	Carmel	---
MW-57	Active	N36°54.985'	W111°23.565'	4301.2	Monitor	8/19/1980	35	4" PVC	35	15	35	Carmel	---
MW-62	Active	N36°54.752'	W111°23.380'	4350.2	Monitor	8/22/1980	45	4" PVC	45	25	45	Carmel	---
MW-63	Active	N36°54.384'	W111°23.805'	4338.1	Monitor	8/22/1980	21	4" PVC	21	3	21	Carmel	---
MW-64	Active	N36°54.304'	W111°23.432'	4364.2	Monitor	10/11/1985	25	4" PVC	25	5	23	Carmel	---
MW-65	Active	N36°54.344'	W111°23.395'	4364.7	Monitor/Pump Back	10/12/1985	28	4" PVC	27	9	27	Carmel	---
MW-66	Active	N36°54.348'	W111°23.338'	4363.4	Monitor/Pump Back	10/12/1985	28	4" PVC	28	17	28	Carmel	---
MW-68	Active	N36°54.308'	W111°23.502'	4361.8	Monitor	10/1/1985	25	4" PVC	25	16	24	Carmel	---

Well ID	*Status*	*Latitude*	*Longitude*	*Altitude of Land Surface (ft msl)*	*Well Type*	*Original Drill Year*	*Drilled Depth (ft bgs)*	*Casing Diameter/Type*	*Casing Depth (ft bgs)*	*Depth to Top of Perforated Interval (ft bgs)*	*Depth to Bottom of Perforated Interval (ft bgs)*	*Formation Monitored*[a]	*Approx. Carmel/PN Contact (ft bgs)*
MW-69	Active	N36°54.351'	W111°23.447'	4365.1	Monitor	10/1/1985	13	4" PVC	12	6	12	Carmel	---
MW-70	Active	N36°54.205'	W111°23.366'	4363.8	Monitor	10/1/1985	13	4" PVC	13			Carmel	---
MW-71	Active			4361.4	Monitor	10/1/1985	23	4" PVC	22	16	22	Carmel	---
MW-73	Active				Monitor/Pump Back	10/24/2013	37	4" PVC	35	15	35	Carmel	
DW1*	Active	N36°54.932'	W111°23.825'	4298.6	Deep Monitor	2/26/1979	1200	4" Steel	700	open	borehole	Navajo	50
DW2**	Active	N36°54.442'	W111°23.229'	4366.2	Deep Monitor	11/25/1981	1500		660	open	borehole	Navajo	---
DW3***	Active	N36°54.897'	W111°23.435'	4424.1	Deep Monitor	11/25/1981	1500	8" Steel	20	open	borehole	Navajo	---
Inactive Wells													
MW-1	Disturbed			4352.0	Monitor	11/16/73	71	2" PVC	71	61	71	PN	
MW-9	Disturbed			4356.6	Monitor	10/30/73	88	2" PVC	88	78	88	PN	
MW-13	Disturbed			4310.2	Monitor	8/1/78	60	4" PVC	60	0	60	Carmel/PN	42
MW-17	Disturbed			4435.9	Monitor	7/30/78	52	4" PVC	52	0	52	Dune/PN	5
MW-22	Disturbed			4288.9	Monitor	12/10/75	18	4" PVC	18	17	18	Carmel	
MW-26	filled w/ sand	N36°54.408'	W111°23.510'	4367.8	Monitor	7/2/78	49	4" PVC	49	0	49	Carmel/PN	43
MW-28	Unable to Locate	N36°54.474'	W111°23.519'	4370.0	Monitor	6/30/78	61	2" PVC	61	0	61	Carmel/PN	54
MW-34	Unable to Locate	N36°54.343'	W111°23.372'	4362.7	Monitor	7/17/78	33	4" PVC	32	0	32	Carmel	32
MW-35	Unable to Locate			4368.8	Monitor	7/1/78	27	2" PVC	27	0	27	Carm/PN	21
MW-36	Unable to Locate			4363.0	Monitor	7/1/78	20	2" PVC	20	0	20	Carm/PN	13
MW-37	Disturbed			4364.9	Monitor	7/2/78	12	4" PVC	12	0	12	Carm/PN	4
MW-38	Unable to Locate			4365.0	Monitor	7/4/78	20	4" PVC	20	0	20	Carm/PN	5
MW-39	Disturbed			4363.7	Monitor	7/16/78	33	4" PVC	33	0	33	Carm/PN	28
MW-47	Unable to Locate			4415.5	Monitor	11/8/73	60	2" PVC	60	30	60	PN	---
MW-49	Unable to Locate			4401.5	Monitor	12/4/74	45	2" PVC	45	25	43	PN	---
MW-54	Unable to Locate	N36°54.846'	W111°23.605'	4364.5	Monitor	7/27/78	18	2" PVC	18	0	18	Carmel	---
MW-58	Unable to Locate			4309.1	Monitor	8/20/80	35	4" PVC	35	15	35	Carmel	---
MW-59	Unable to Locate			4309.1	Monitor	8/21/80	27	4" PVC	27	7	27	Carmel	---

Well ID	*Status*	*Latitude*	*Longitude*	*Altitude of Land Surface (ft msl)*	*Well Type*	*Original Drill Year*	*Drilled Depth (ft bgs)*	*Casing Diameter/Type*	*Casing Depth (ft bgs)*	*Depth to Top of Perforated Interval (ft bgs)*	*Depth to Bottom of Perforated Interval (ft bgs)*	*Formation Monitored*[a]	*Approx. Carmel/PN Contact (ft bgs)*
MW-61	Unable to Locate			4267.3	Monitor	8/22/80	29	4" PVC	29	19	29	PN	18
MW-67	Disturbed				Monitor								
Well Abandonments													
MW-5	12/22/2013	N36°54.943'	W111°23.394'	4312.0	Monitor	10/31/73	58	2" PVC	58	48	58	PN	45
MW-7	12/21/2013			4310.9	Monitor	11/1/73	40	2" PVC	40	30	40	PN	
MW-18	12/22/2013			4225.9	Monitor	12/9/75	63	4" PVC	63	62	63	PN	---
MW-20	12/19/2013			4220.8	Monitor	12/5/75	54	4" PVC	54	53	54	PN	---
MW-27	12/20/2013	N36°54.438'	W111°23.401'	4368.7	Monitor	7/1/78	52	2" PVC	52	0	52	Carmel/PN	47
MW-31	10/22/2013	N36°54.375'	W111°23.591'	4363.5	Monitor	7/3/1978	33	2" PVC	33	0	33	Carmel	
MW-40	12/17/2013	N36°53.941'	W111°23.376'	4393.2	Monitor	6/14/78	40	4" PVC	38	0	38	Carm/PN	14
MW-41	12/20/2013	N36°53.982'	W111°23.268'	4391.0	Monitor	6/14/78	20	4" PVC	19	0	19	Carm/PN	13
MW-42	12/16/2013	N36°54.012'	W111°23.377'	4390.8	Monitor	6/14/78	25	4" PVC	20	0	20	Carm/PN	17.5
MW-44	12/16/2013	N36°53.960'	W111°23.312'	4389.5	Monitor	6/19/78	20	4" PVC	19	0	19	Carm/PN	8
MW-45	12/16/2013	N36°53.973'	W111°23.277'	4390.6	Monitor	6/19/78	20	4" PVC	20	0	20	Carm/PN	8.5
MW-46	12/17/2013	N36°54.000'	W111°23.278'	4391.8	Monitor	6/19/78	30	4" PVC	29	0	29	Carm/PN	14
MW-48	12/19/2013			4409.6	Monitor	12/4/74	57	2" PVC	57	47	57	PN	---
MW-50	12/20/2013			4421.9	Monitor	11/14/73	87	2" PVC	87	77	87	PN	---
Well Abandonments Scheduled during 2015													
MW-29A	Active	N36°54.524'	W111°23.454'	4369.1	Monitor	6/30/1978	66	2" PVC	66	56	66	Carmel/PN	56
MW-60	Active	N36°54.856'	W111°23.902'	4258.2	Monitor	8/21/1980	34	4" PVC	34	14	34	PN?	---

Notes:

* Casing liner installed Feb 2008 to depth of 700 feet bgs; open borehole from 700 feet to total depth.

** Casing liner installed 1989 to depth of 660 feet bgs; open borehole from 660 feet to total depth

*** Casing liner installation scheduled for 2015.

[a] Drillers logs do not differentiate the Jurassic age Page Sandstone from Triassic-Jurassic age Navajo Sandstone, both present beneath the plant site and Ash Disposal Landfill. Sandstone units are referred to only as Navajo Sandstone. The Page Sandstone is approximately 120 to 180 feet thick beneath the NGS facility and is separated from the Navajo Sandstone by a regional unconformity termed the J-2 unconformity. Therefore, upper sandstone units are referred to in this report as Page/Navajo Sandstone or PN

msl = mean sea level

bgs = below ground surface

Table 2. Well Construction Details for NGS Neutron Wells.

Well ID	*Status*	*Latitude*	*Longitude*	*Altitude of Land Surface (ft msl)*	*Well Type*	*Original Drill Year*	*Drilled Depth (ft bgs)*	*Casing Diameter/Type*	*Casing Depth (ft bgs)*	*Formation Monitored* [a]	*Approx. Carmel/PN Contact (ft bgs)*
N-2	unknown	N36°54.667'	W111°23.910'	4338.4	Neutron	7/25/1978	50	2.0" AW Steel	50	Carmel	---
N-3	unknown	N36°54.933'	W111°23.821'	4298.9	Neutron	7/26/1978	52	2.0" AW Steel	52	Carmel/PN	51
N-4	unknown	N36°54.982'	W111°23.541'	4299.8	Neutron	7/31/1978	70	2.0" AW Steel	70	Carmel/PN	63
N-8	unknown	N36°54.662'	W111°23.773'	4246.1	Neutron	7/31/1978	50	2.0" AW Steel	50	Fill/PN	3
N-10	unknown	N36°54.595'	W111°23.930'	4327.0	Neutron	7/17/1978	50	2.0" AW Steel	50	Dune/Carmel/PN	16
N-11	unknown			4344.2	Neutron	7/29/1978	63	2.0" AW Steel	58	Fill/Carmel/PN	62
N-12	unknown	N36°54.630'	W111°23.592'	4357.5	Neutron	7/30/1978	72	2.0" AW Steel	70	Fill/Carmel/PN	66
N-14	unknown	N36°54.892'	W111°23.067'	4264.6	Neutron	7/28/1978	50	2.0" AW Steel	50	Fill/PN	27
N-15	unknown	N36°54.754'	W111°23.356'	4214.8	Neutron	7/28/1978	50	2.0" AW Steel	50	Fill/Carmel/PN	5
N-16	unknown			4267.0	Neutron	7/11/1978	50	2.0" AW Steel	44	Dune/PN	24
N-24	unknown			---	Neutron	6/17/1978	140	2.0" AW Steel	140	Carmel/PN	34
N-25	unknown	N36°54.335'	W111°23.447'	4361.9	Neutron	6/13/1978	149	2.0" AW Steel	149	Carmel/PN	4
N-51	unknown	N36°54.507'	W111°23.596'	4387.7	Neutron	6/7/1978	50	2.0" AW Steel	50	Dune/PN	10
N-52	unknown	N36°54.472'	W111°23.616'	4384.0	Neutron	6/7/1978	50	2.0" AW Steel	50	Dune/PN	4
N-53	unknown	N36°54.702'	W111°23.611'	4385.4	Neutron	6/8/1978	52	2.0" AW Steel	52	Dune/PN	8
N-55	unknown	N36°54.634'	W111°23.404'	---	Neutron	6/10/1978	97	2.0" AW Steel	97	Fill/Dune/PN	
N-72	unknown	N36°54.785'	W111°23.283'		Neutron	1/14/1997	445	4" Steel	440	Ash/PN	38

Notes:

[a] Drillers logs do not differentiate the Jurassic age Page Sandstone from Triassic-Jurassic age Navajo Sandstone, both present beneath the plant site and Ash Disposal Landfill. Sandstone units are referred to only as Navajo Sandstone. The Page Sandstone is approximately 120 to 180 feet thick beneath the NGS facility and is separated from the Navajo Sandstone by a regional unconformity termed the J-2 unconformity. Therefore, upper sandstone units are referred to in this report as Page/Navajo Sandstone or PN

Table 3. Water Level Data, NGS Monitor Wells, November 2012.

Well ID	*Measuring Pt. Elevation (ft msl)*	*Depth to Water (ft bgs)*	*Water Level Elevation (ft msl)*
MW-5	4312.0	Dry	---
MW-6	4312.2	21.05	4291.2
MW-7	4311.0	25.55	4285.5
MW-18	4226.0	Dry	---
MW-19	4316.5	16.73	4299.8
MW-20	4220.8	52.76	4168.0
MW-21	4290.3	15.64	4274.6
MW-23	4316.4	15.32	4301.1
MW-27	4368.7	36.83	4331.9
MW-29A	4369.1	65.31	4303.8
MW-29B	4369.3	11.77	4357.5
MW-30	4363.7	Dry	---
MW-31	4363.5	17.05	4346.5
MW-32A	4364.3	10.15	4354.2
MW-32B	4364.3	10.36	4353.9
MW-33	4364.1	8.66	4355.4
MW-40	4393.2	Dry	---
MW-41	4391.0	Dry	---
MW-42	4390.8	Dry	---
MW-43	4389.4	14.10	4375.3
MW-44	4389.5	Dry	---
MW-45	4389.6	Dry	---
MW-46	4391.8	Dry	---
MW-47	4415.5	Dry	---
MW-48	4409.6	Dry	---
MW-50	4421.9	Dry	---
MW-56	4302.0	Dry	---
MW-57	4301.2	18.00	4283.2
MW-60	4258.2	Dry	---
MW-62	4350.2	24.81	4325.4
MW-63	4338.1	9.32	4328.7
MW-64	4364.2	9.88	4354.3
MW-65	4364.7	6.99	4357.7
MW-66	4363.4	Site being pumped	No measurement
MW-68	4361.8	16.52	4345.3
MW-69	4365.1	Dry	---
MW-70	4363.8	9.84	4354.0
MW-71	4361.4	19.50	4341.9
DW-1	4298.6	837.90	3460.7
DW-2	4366.2	910.00	3456.2
DW-3	4424.1	919.60	3504.5

Table 4. Summary of Metal Sampling Results for NGS Deep Wells, 2011-12.

	EPA MCL	EPA Method	DW-1		DW-2		DW-3	
			5/8/12	5/18/11	5/8/12	5/18/11	5/8/12	5/18/11
Metals (all units in mg/l)								
Aluminum	SMCL	200.8	0.401	0.89	0.468	0.662	0.838	1.68
Antimony	0.006	200.8	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Arsenic	0.01	200.8	0.0024	0.0036	<0.002	0.0028	0.0050	0.0062
Barium	2	200.7	0.403	0.487	0.211	0.201	0.252	0.413
Beryllium	0.004	200.8	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium	0.005	200.8	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium	0.1	200.7	<0.010	0.010	<0.010	<0.010	<0.010	<0.010
Copper	TT8 Action Level = 1.3	200.7	<0.010	<0.010	<0.010	<0.010	0.0100	0.0100
Iron	SMCL	200.7	13.7	15.7	26.5	25.7	1.47	3.02
Lead	TT8 Action Level = 0.015	200.8	0.002	0.0022	0.0094	0.0114	0.0132	0.0304
Mercury	0.002	245.1	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel	NE	200.8	0.0048	0.0048	0.0066	0.0058	0.0026	0.0036
Selenium	0.05	200.8	<0.002	<0.002	<0.002	<0.002	0.002	<0.002
Silver	SMCL	200.8	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Thallium	0.002	200.8	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium	NE	200.8	0.0142	0.148	0.0152	0.0164	0.0164	0.0214
Zinc	SMCL	200.7	0.022	0.022	0.087	0.078	0.175	0.391

Notes:

MCL - Maximum Contaminant Level

SMCL - Secondary MCL

NE - None Established

Table 5. Results of Metals Sampling, Shallow Wells, October 1996 (SRP Sampling) and May 2002 (EPA/NSP Site Investigation). (All units in mg/l.)

Constituent*	EPA MCL	TCLP Limit	MW-20	MW-21		MW-23	MW-31	MW-43	MW-54	MW-57	MW-6		MW-62	MW-63		MW-64	MW-66	MW-70
			10/30/1996	10/30/1996	5/16/2002**	10/30/1996	10/30/1996	10/30/1996	10/30/1996	10/30/1996	10/30/1996	5/16/2002**	10/30/1996	10/30/1996	5/16/2002**	10/30/1996	10/30/1996	10/30/1996
Aluminum	SMCL	NE	0.301	0.231	<0.10	---	0.156	---	0.294	0.371	0.224	<0.10	0.362	0.365	<0.10	0.086	0.082	---
Antimony	0.006	NE	---	---	<0.010	---	---	---	---	---	---	<0.010	---	---	<0.010	---	---	---
Arsenic	0.01	5	<0.02	0.16	0.017	---	<0.08	---	<0.08	<0.08	0.9	0.2	0.08	<0.08	<0.010	<0.08	<0.02	---
Arsenic, total			*<0.2*	*<0.2*	---	*<0.2*	*<0.2*	*<0.2*	*<0.2*	*0.25*	*0.4*	---	*<0.2*	*0.3*	---	*<0.2*	*<0.2*	*<0.2*
Barium	2	100	0.023	0.018	0.014	---	0.03	---	0.053	0.019	0.016	0.014	0.018	0.047	0.024	0.065	0.021	---
Barium, total			*0.038*	*0.022*	---	*0.091*	*0.601*	*0.543*	*1.43*	*0.487*	*0.064*	---	*0.523*	*0.319*	---	*0.064*	*0.021*	*0.232*
Beryllium	0.004	NE	---	---	<0.0010	---	---	---	---	---	---	<0.0010	---	---	<0.0010	---	---	---
Cadmium	0.005	1	<0.01	<0.01	<0.0030		<0.01		<0.01	<0.01	<0.01	<0.0030	<0.01	<0.01	<0.0030	<0.01	<0.01	
Cadmium, total			*<0.01*	*<0.01*	---	*<0.01*	*<0.01*	*<0.01*	*<0.01*	*<0.01*	*<0.01*	---	*<0.01*	*<0.01*	---	*<0.01*	*<0.01*	*<0.01*
Calcium	NE	NE	542	540	440	---	470	---	842	586	585	440	572	952	780	142	189	---
Chromium	0.1	5	<0.010	<0.010	<0.010	---	<0.010	---	<0.010	<0.010	0.056	0.032	<0.010	<0.010	<0.010	<0.010	<0.010	---
Chromium, total			*<0.01*	*<0.01*	---	*0.011*	*0.098*	*0.059*	*0.046*	*0.026*	*0.06*	---	*0.022*	*0.046*	*<0.01*	*<0.01*	*<0.01*	*0.019*
Cobalt	NE	NE	---	---	<0.010	---	---	---	---	---	---	0.88	---	---	<0.010	---	---	---
Copper	TT8, Action Level=1.3	NE	---	---	0.051	---	---	---	---	---	---	0.2	---	---	0.017	---	---	---
Iron	secondary	NE	0.02	0.136	<0.10	---	<0.010	---	<0.010	0.079	2.75	0.86	0.145	1.95	3.7	1.24	0.576	---
Lead	TT8, Action Level=0.015	5	0.063	0.1	<0.010	---	0.115	---	0.134	0.12	0.199	0.024	0.093	0.18	<0.010	0.061	0.063	---
Lead, total			*0.068*	*0.113*		*0.144*	*0.194*	*0.172*	*0.225*	*0.183*	*0.227*		*0.177*	*0.273*		*0.052*	*0.073*	*0.074*
Magnesium	NE	NE	185	580	560	---	722	---	961	713	3420	4600	473	1370	1100	225	152	---
Manganese	SMCL	NE			0.023							7.1			0.15			
Nickel	NE	NE	---	---	0.044	---	---	---	---	---	---	0.45	---	---	0.028	---	---	---
Potassium	NE	NE	4.4	17.7	33	---	40.8	---	19	9.1	20.5	80	12.2	16.7	29	32	25.4	---
Selenium	0.05	1	0.099	0.173	0.053	---	0.319	---	0.308	0.193	0.27	0.052	0.137	0.254	0.054	0.086	0.099	---

Constituent*	EPA MCL	TCLP Limit	MW-20	MW-21		MW-23	MW-31	MW-43	MW-54	MW-57	MW-6		MW-62	MW-63		MW-64	MW-66	MW-70
Selenium, total			*0.111*	*0.189*	---	*0.185*	*0.349*	*0.251*	*0.412*	*0.263*	*0.311*	---	*0.233*	*0.403*	---	*0.082*	*0.123*	*0.116*
Silver	SMCL	5	<0.01	<0.01	<0.0050		<0.01		<0.01	<0.01	<0.01	<0.0050	<0.01	<0.01	<0.0050	<0.01	<0.01	
Silver, total			*<0.01*	*<0.01*	---	*<0.01*	*<0.01*	*<0.01*	*<0.01*	*<0.01*	*<0.01*	---	*<0.01*	*<0.01*	---	*<0.01*	*<0.01*	*<0.01*
Sodium	NE	NE	2720	1720	1400	---	2640	---	1100	1440	10700	8300	552	681	500	513	1340	---
Thallium	0.002	NE	---	---	<0.050	---	---	---	---	---	---	<0.050	---	---	<0.050	---	---	---
								`										
Vanadium	NE	NE	---	---	0.048	---	---	---	---	---	---	---	---	---	<0.010	---	---	---
Zinc	SMCL	NE	---	---	0.29	---	---	---	---	---	---	2.3	---	---	<0.05	---	---	---
Mercury	0.002	0.2	<0.0002	<0.0002	<0.0002	---	<0.0002	---	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	---
Mercury, total			*<0.0002*	*<0.0002*	---	*<0.0020*	*<0.0002*	*<0.0002*	*<0.0002*	*<0.0002*	*<0.0002*	---	*<0.0002*	*<0.0002*	---	*<0.0002*	*<0.0002*	*<0.0002*

Notes:
* Dissolved concentrations except where noted.
** EPA/NSP Site Investigation, May 2002.
MCL - Maximum Contaminant Level
SMCL - Secondary MCL
NE - None Established

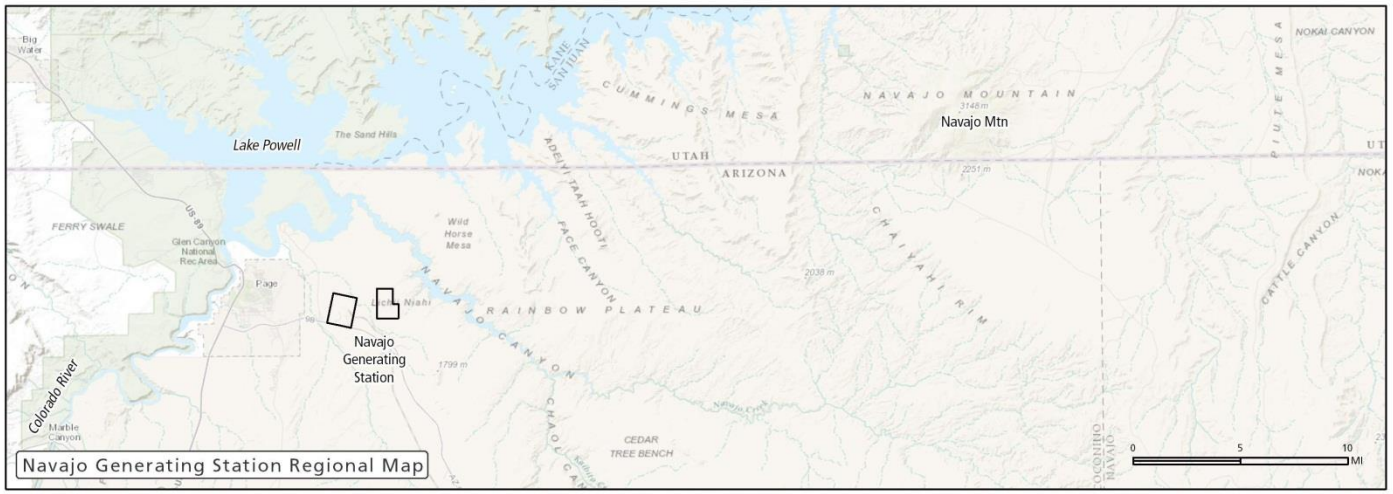
Table 6. Concentrations of Petroleum Hydrocarbons in NGS Shallow Monitor Wells, 1996 and 1998.

Well ID	Sample Collection Date	Constituent	Lab Result	Unit of Measure	Lab Reporting Limit	Lab Method
MW-6	10/30/1996	TOTAL PETROLEUM HYDROCARBONS	<0.5			
MW-20	10/30/1996	TOTAL PETROLEUM HYDROCARBONS	<0.5			
MW-21	10/30/1996	TOTAL PETROLEUM HYDROCARBONS	<0.5			
MW-23	10/30/1996	TOTAL PETROLEUM HYDROCARBONS	<0.5			
MW-27	5/12/1998	TOTAL PETROLEUM HYDROCARBONS	0.9	MG/L	0.1	418.1AZ
MW-43	10/30/1996	TOTAL PETROLEUM HYDROCARBONS	<0.5			
MW-54	10/30/1996	TOTAL PETROLEUM HYDROCARBONS	<0.5			
MW-57	10/30/1996	TOTAL PETROLEUM HYDROCARBONS	<0.5			
MW-62	10/30/1996	TOTAL PETROLEUM HYDROCARBONS	<0.5	MG/L		
MW-63	10/30/1996	TOTAL PETROLEUM HYDROCARBONS	<0.5			
MW-64	10/30/1996	TOTAL PETROLEUM HYDROCARBONS	37			
MW-66	10/30/1996	TOTAL PETROLEUM HYDROCARBONS	<0.5			
MW-62	5/12/1998	TOTAL PETROLEUM HYDROCARBONS	0.1	MG/L	0.1	418.1AZ
MW-62	5/12/1998	CONDUCTIVITY	6690	UMHOS/ CM		120.1
MW-62	5/12/1998	PH	7.1	UNITS	1.0	150.1
MW-62	5/12/1998	TEMPERATURE	16.4	DEGREE S C		170.1
MW-64	5/12/1998	TOTAL PETROLEUM HYDROCARBONS	7.7	MG/L	0.1	418.1AZ
MW-64	5/12/1998	TEMPERATURE	17.6	DEGREE S C		170.1
MW-64	5/12/1998	TOLUENE	BRL	UG/L	0.5	602
MW-64	5/12/1998	XYLENES, TOTAL	BRL	UG/L	0.5	602
MW-64	5/12/1998	M,P-XYLENES	BRL	UG/L	1.0	602
MW-64	5/12/1998	O-XYLENE	BRL	UG/L	0.5	602
MW-64	5/12/1998	PH	7.1	UNITS	1.0	150.1
MW-64	5/12/1998	BENZENE	BRL	UG/L	0.5	602
MW-64	5/12/1998	ETHYLBENZENE	BRL	UG/L	0.5	602
MW-64	5/12/1998	CONDUCTIVITY	5610	UMHOS/ CM		120.1
MW-65	5/12/1998	TOTAL PETROLEUM HYDROCARBONS	BRL	MG/L	0.1	418.1AZ

Well ID	Sample Collection Date	Constituent	Lab Result	Unit of Measure	Lab Reporting Limit	Lab Method
MW-65	5/12/1998	CONDUCTIVITY	3260	UMHOS/ CM		120.1
MW-65	5/12/1998	PH	7.6	UNITS	1.0	150.1
MW-65	5/12/1998	TEMPERATURE	17.4	DEGREE S C		170.1
MW-66	5/12/1998	TOTAL PETROLEUM HYDROCARBONS	0.1	MG/L	0.1	418.1AZ
MW-66	5/12/1998	CONDUCTIVITY	6900	UMHOS/ CM		120.1
MW-66	5/12/1998	PH	7.5	UNITS	1.0	150.1
MW-66	5/12/1998	TEMPERATURE	16.6	DEGREE S C		170.1
MW-68	5/12/1998	TOTAL PETROLEUM HYDROCARBONS	0.1	MG/L	0.1	418.1AZ
MW-68	5/12/1998	TEMPERATURE	19.7	DEGREE S C		170.1
MW-68	5/12/1998	TOLUENE	BRL	UG/L	0.5	602
MW-68	5/12/1998	XYLENES, TOTAL	BRL	UG/L	0.5	602
MW-68	5/12/1998	M,P-XYLENES	BRL	UG/L	1.0	602
MW-68	5/12/1998	O-XYLENE	BRL	UG/L	0.5	602
MW-68	5/12/1998	PH	7.7	UNITS	1.0	150.1
MW-68	5/12/1998	BENZENE	BRL	UG/L	0.5	602
MW-68	5/12/1998	ETHYLBENZENE	BRL	UG/L	0.5	602
MW-68	5/12/1998	CONDUCTIVITY	980	UMHOS/ CM		120.1
MW-70	5/12/1998	TOTAL PETROLEUM HYDROCARBONS	BRL	MG/L	0.1	418.1AZ
MW-71	5/12/1998	TOTAL PETROLEUM HYDROCARBONS	BRL	MG/L	0.1	418.1AZ
MW-71	5/12/1998	TEMPERATURE	19.5	DEGREE S C		170.1
MW-71	5/12/1998	TOLUENE	BRL	UG/L	0.5	602
MW-71	5/12/1998	XYLENES, TOTAL	BRL	UG/L	0.5	602
MW-71	5/12/1998	M,P-XYLENES	BRL	UG/L	1.0	602
MW-71	5/12/1998	O-XYLENE	BRL	UG/L	0.5	602
MW-71	5/12/1998	PH	7.9	UNITS	1.0	150.1
MW-71	5/12/1998	BENZENE	BRL	UG/L	0.5	602
MW-71	5/12/1998	ETHYLBENZENE	BRL	UG/L	0.5	602
MW-71	5/12/1998	CONDUCTIVITY	6400	UMHOS/ CM		120.1

Figures

ESRI World Topographic Map Base - SRP C&GISS - ngs_groundwater_fig1.mxd 10/8/2014



Pre-Decisional Draft
for Planning and Discussion
Purposes Only

Figure 1.
Navajo Generating Station
Location Map

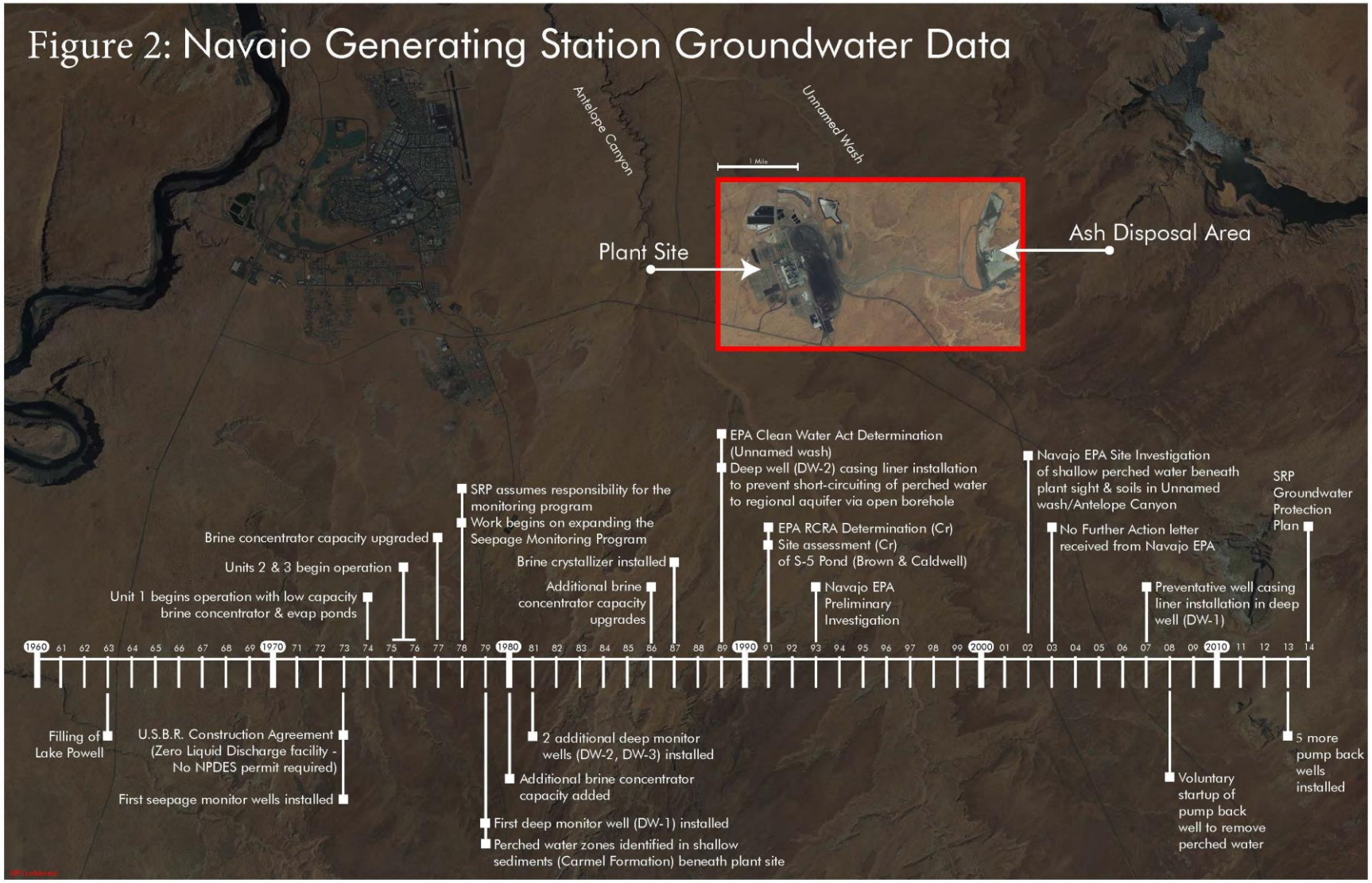


Figure 2: Navajo Generating Station Groundwater Data
Antelope Canyon
Unnamed Wash
1 Mile
Plant Site
Ash Disposal Area
Filling of Lake Powell
U.S.B.R. Construction Agreement (Zero Liquid Discharge facility - No NPDES permit required)
First seepage monitor wells installed
Brine concentrator capacity upgraded
Units 2 & 3 begin operation
Unit 1 begins operation with low capacity brine concentrator & evap ponds
SRP assumes responsibility for the monitoring program
Work begins on expanding the Seepage Monitoring Program
Brine crystallizer installed
Additional brine concentrator capacity upgrades
First deep monitor well (DW-1) installed
Perched water zones identified in shallow sediments (Carmel Formation) beneath plant site
2 additional deep monitor wells (DW-2, DW-3) installed
Additional brine concentrator capacity added
EPA Clean Water Act Determination (Unnamed wash)
Deep well (DW-2) casing liner installation to prevent short-circuiting of perched water to regional aquifer via open borehole
EPA RCRA Determination (Cr)
Site assessment (Cr) of S-5 Pond (Brown & Caldwell)
Navajo EPA Preliminary Investigation
Navajo EPA Site Investigation of shallow perched water beneath plant sight & soils in Unnamed wash/Antelope Canyon
No Further Action letter received from Navajo EPA
Preventative well casing liner installation in deep well (DW-1)
Voluntary startup of pump back well to remove perched water
SRP Groundwater Protection Plan
5 more pump back wells installed
1960 61 62 63 64 65 66 67 68 69 1970 71 72 73 74 75 76 77 78 79 1980 81 82 83 84 85 86 87 88 89 1990 91 92 93 94 95 96 97 98 99 2000 01 02 03 04 05 06 07 08 09 2010 11 12 13 14

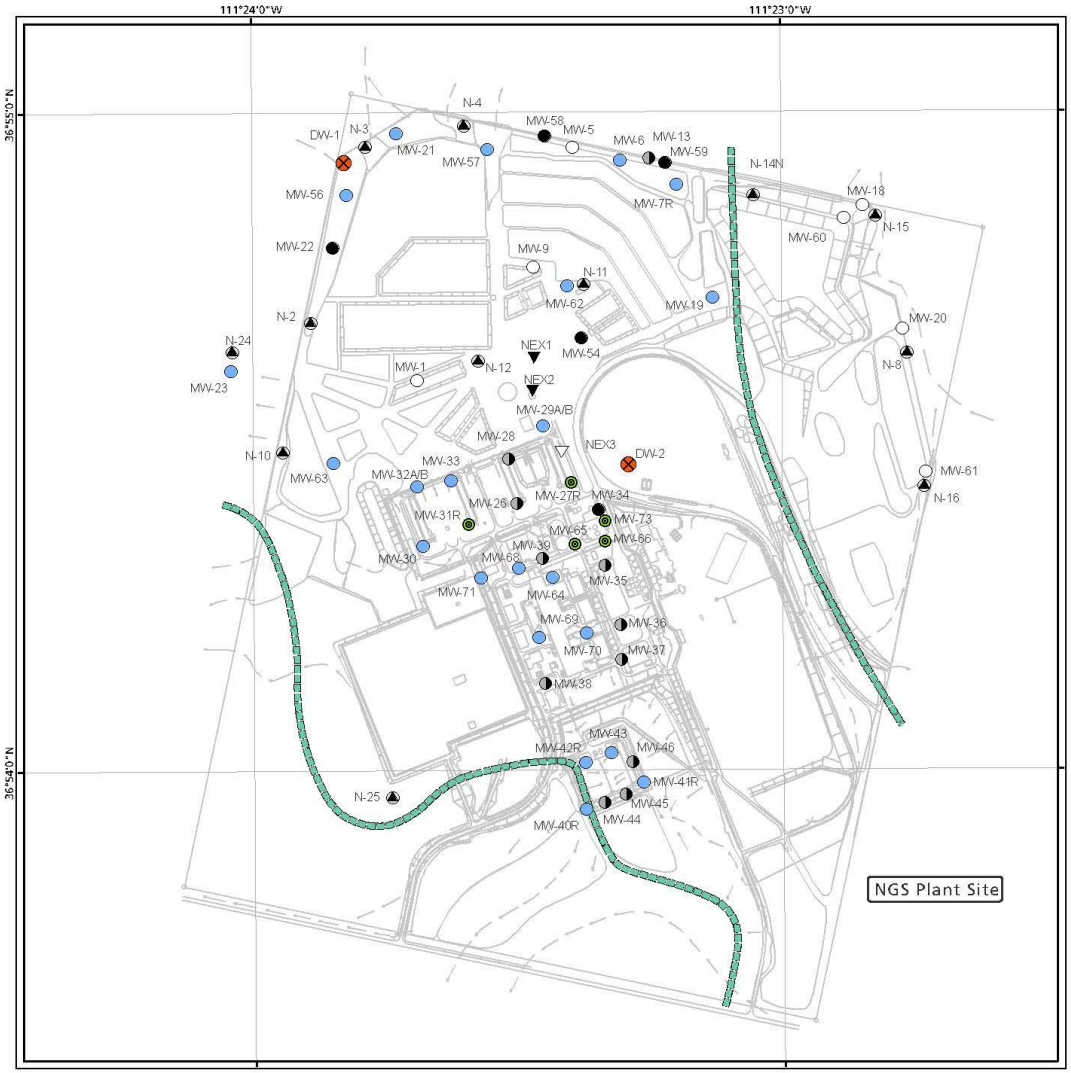
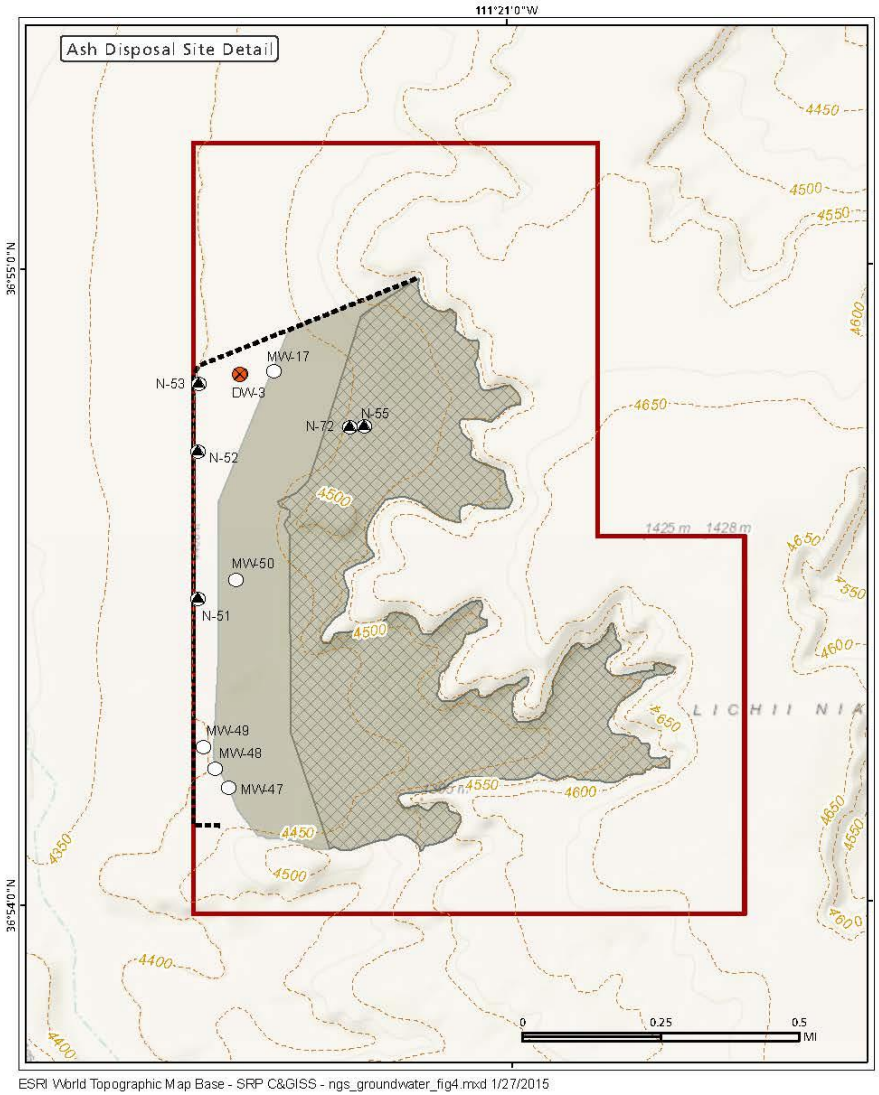


Figure 3.
Well Location Map
NGS Plant Site

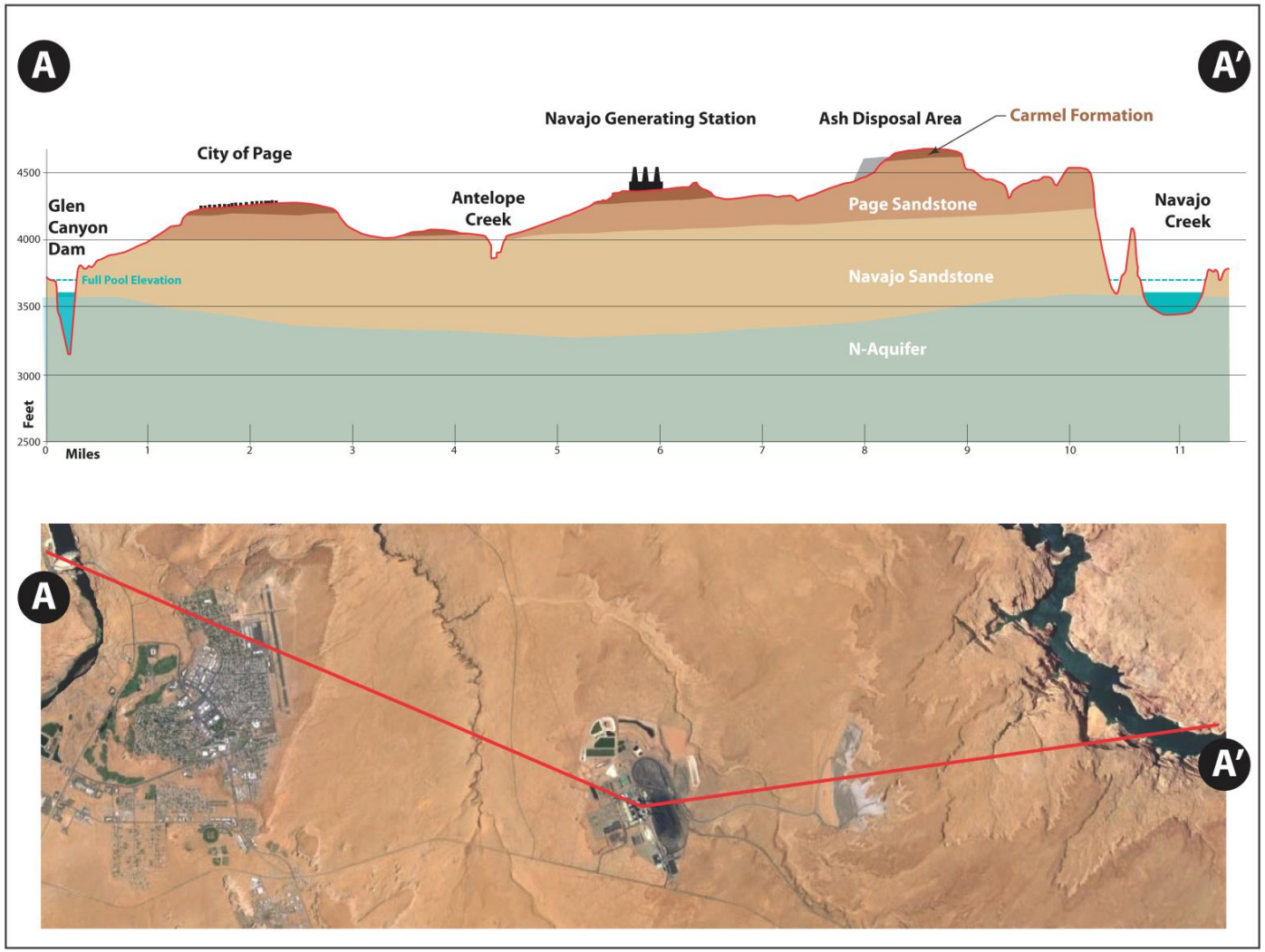


ESRI World Topographic Map Base - SRP C&GISS - ngs_groundwater_fig4.mxd 1/27/2015

Figure 4.
Well Location Map
Ash Disposal Landfill

- Navajo Sandstone Deep Monitor Well
- PN (Page/Navajo Sandstone) Shallow Monitor Well (Inactive)
- Neutron Logging Well (Inactive)
- Disposal Site Property Boundary
- Ash Disposal Area (Active)
- Ash Disposal Area (Inactive)
- Elevation Contour
- Existing Fence Line

Figure 5. Geologic Cross Section A-A`



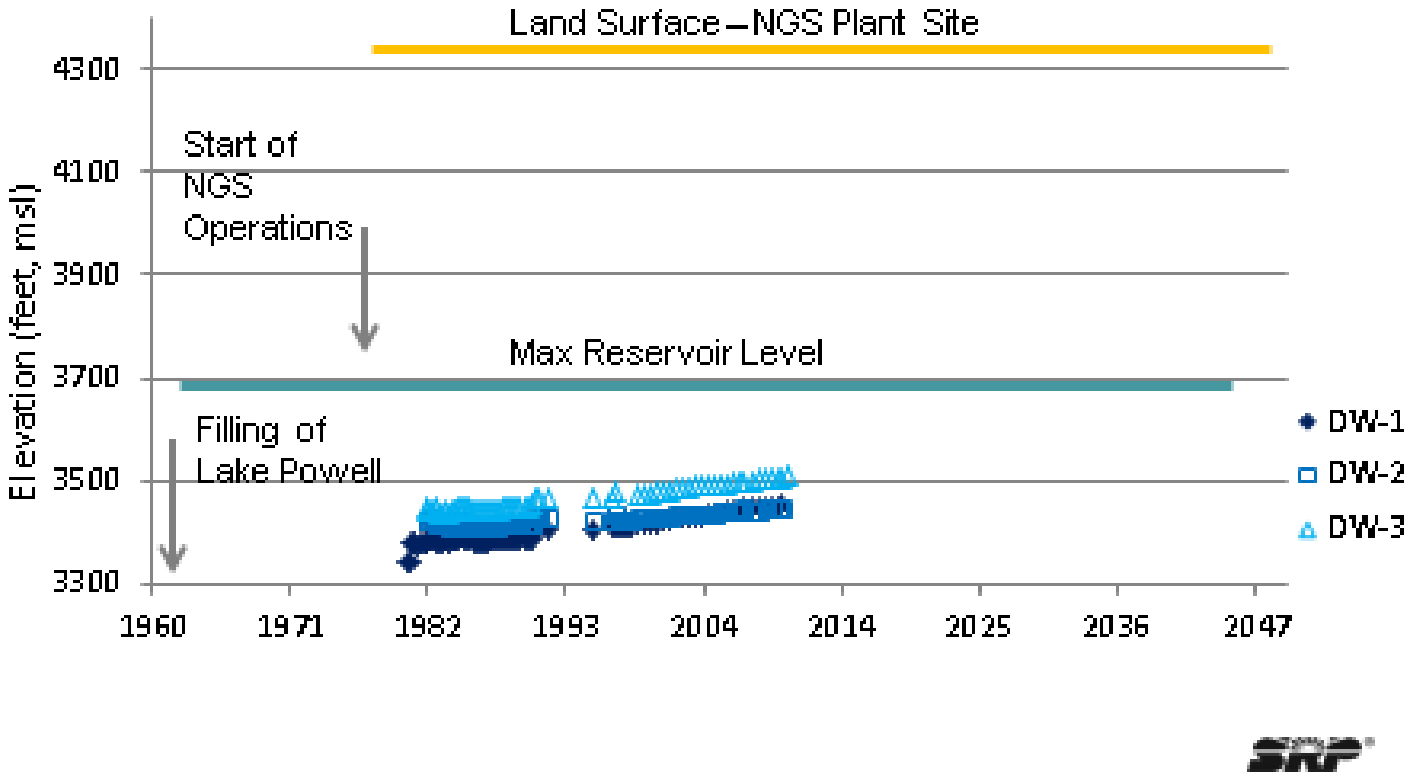


Figure 6a. Water Level Hydrographs of NGS Deep Wells relative to land surface and Lake Powel maximum reservoir

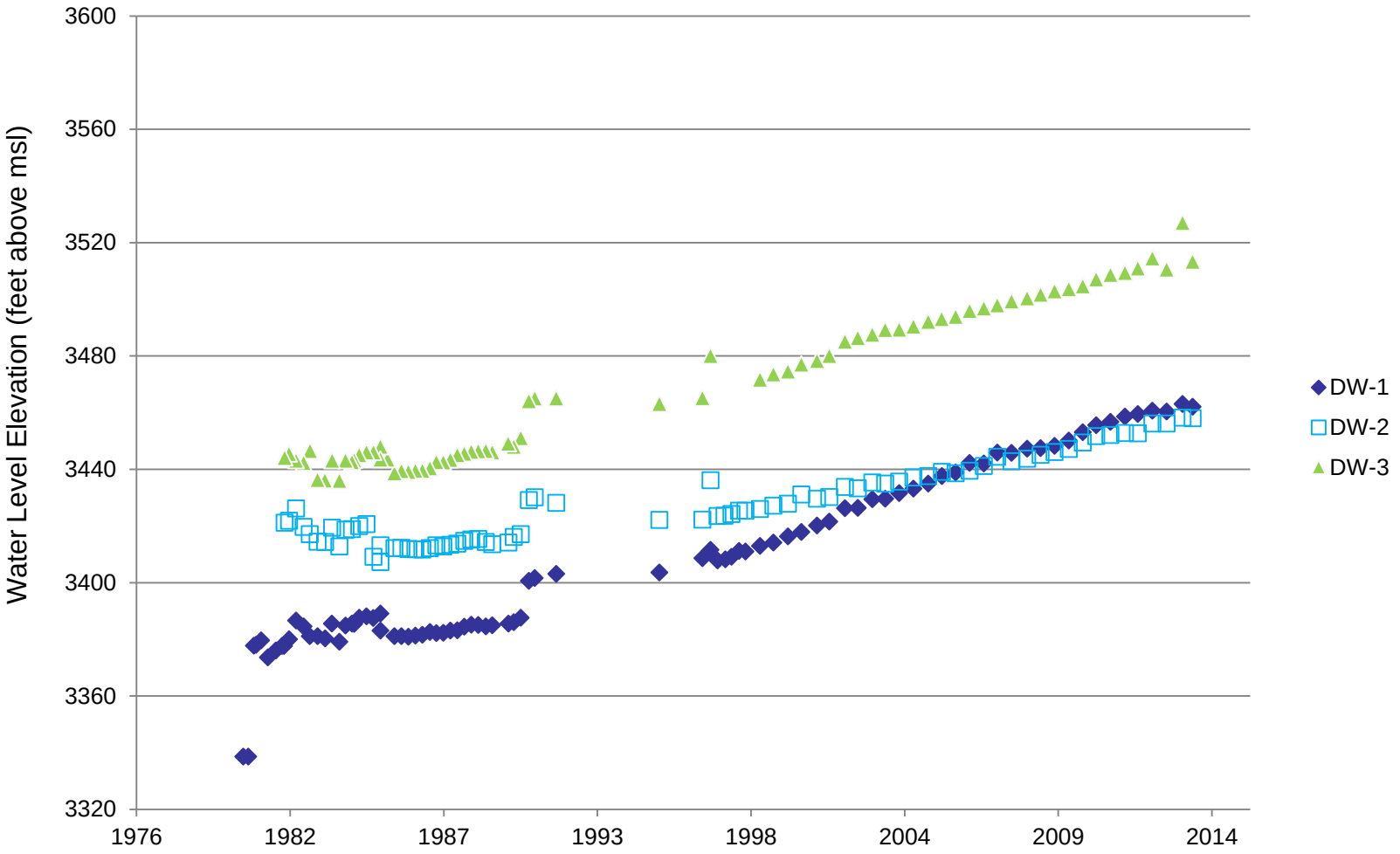
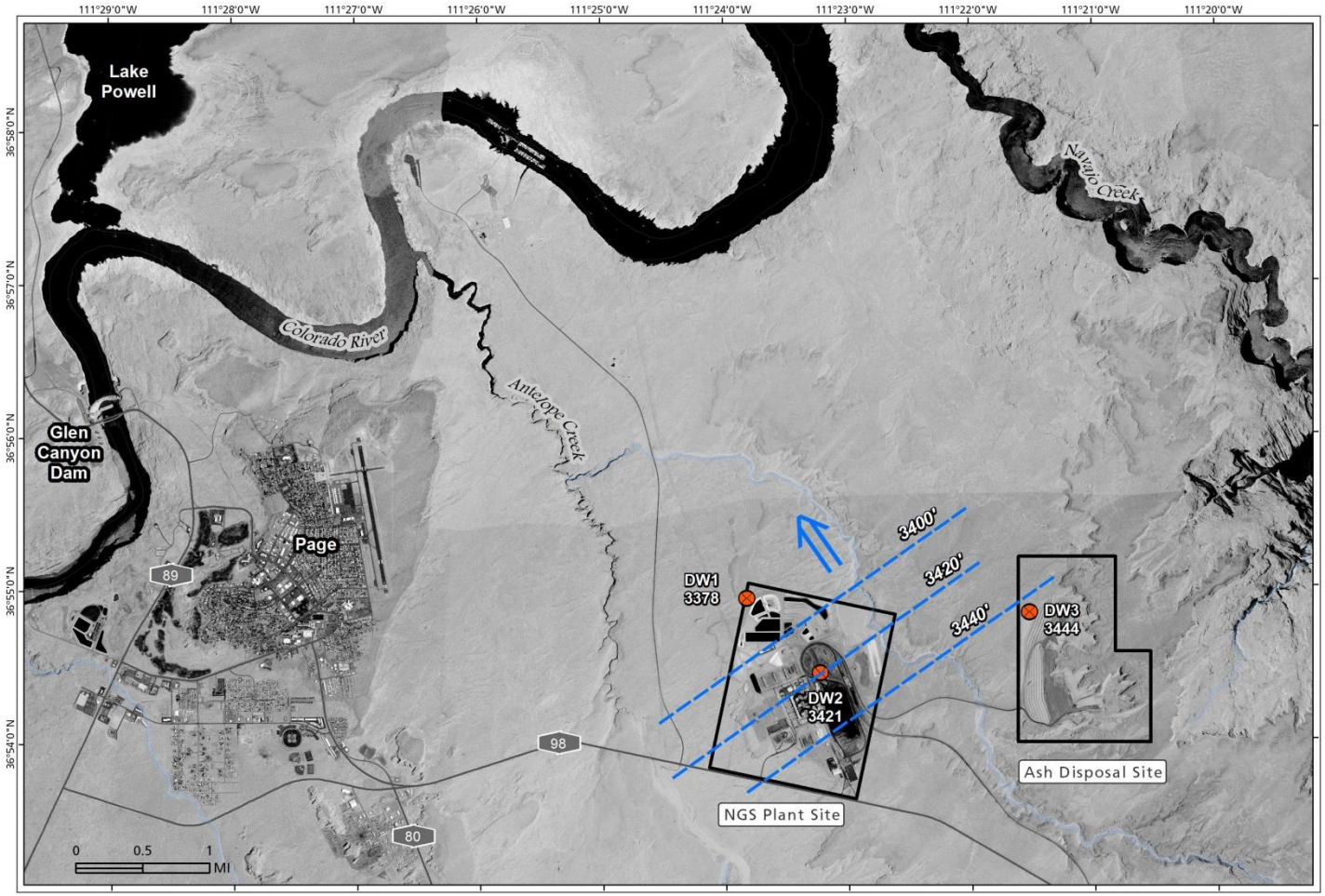


Figure 6b. Water Level Hydrographs, NGS Deep Wells, 1980-Present



DW1 Navajo Sandstone Deep Monitor Well

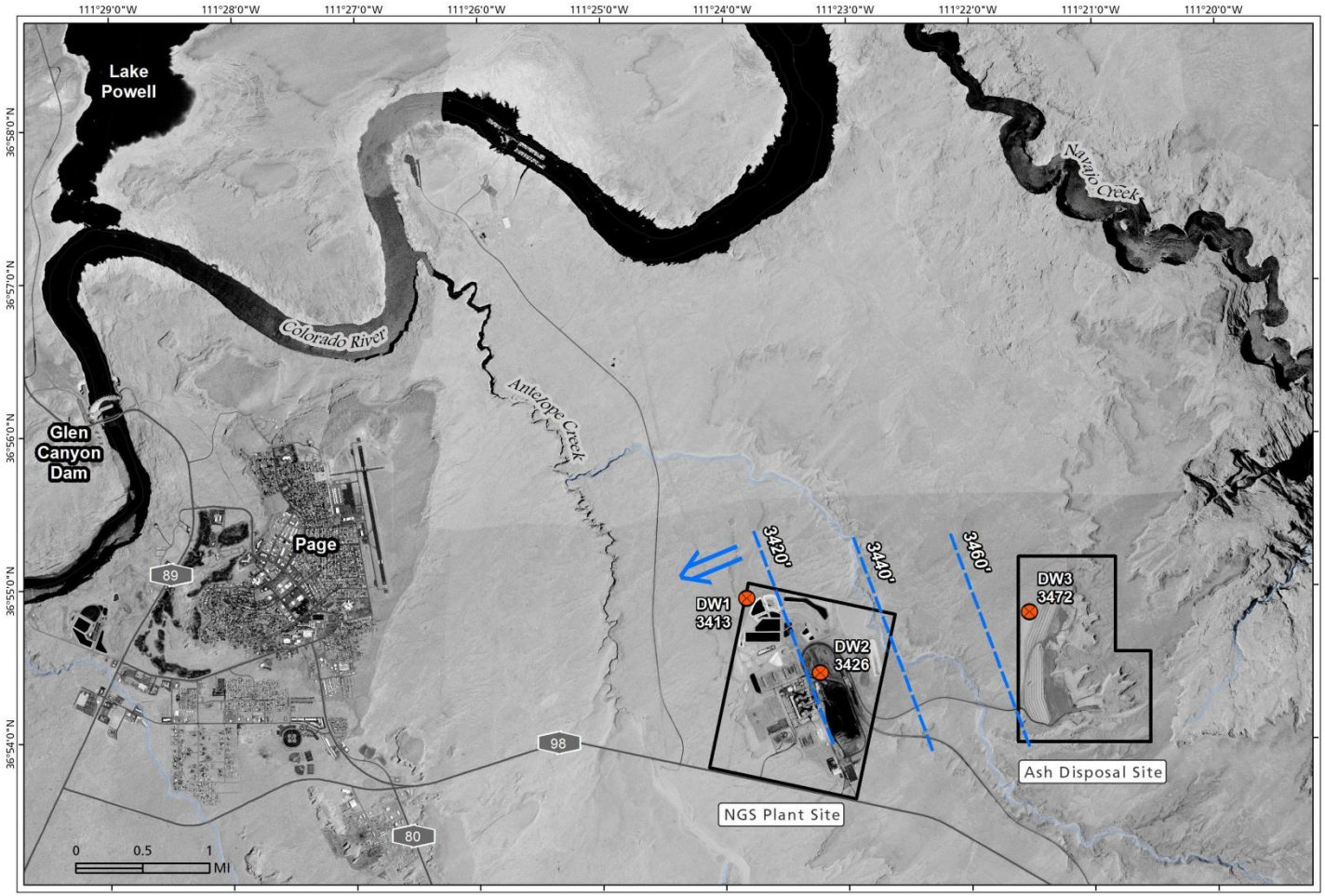
3460' Groundwater Elevation (20' interval)

Approximate Groundwater Flow Direction

Pre-Decisional Draft
for Planning and Discussion
Purposes Only

Figure 7a.
Groundwater Elevation and Flow Direction
Navajo Aquifer, December 1981

ESRI World Topographic Map Base - SRP C&GISS - ngs_groundwater_fig7a.mxd 10/8/2014



DW1 Navajo Sandstone Deep Monitor Well

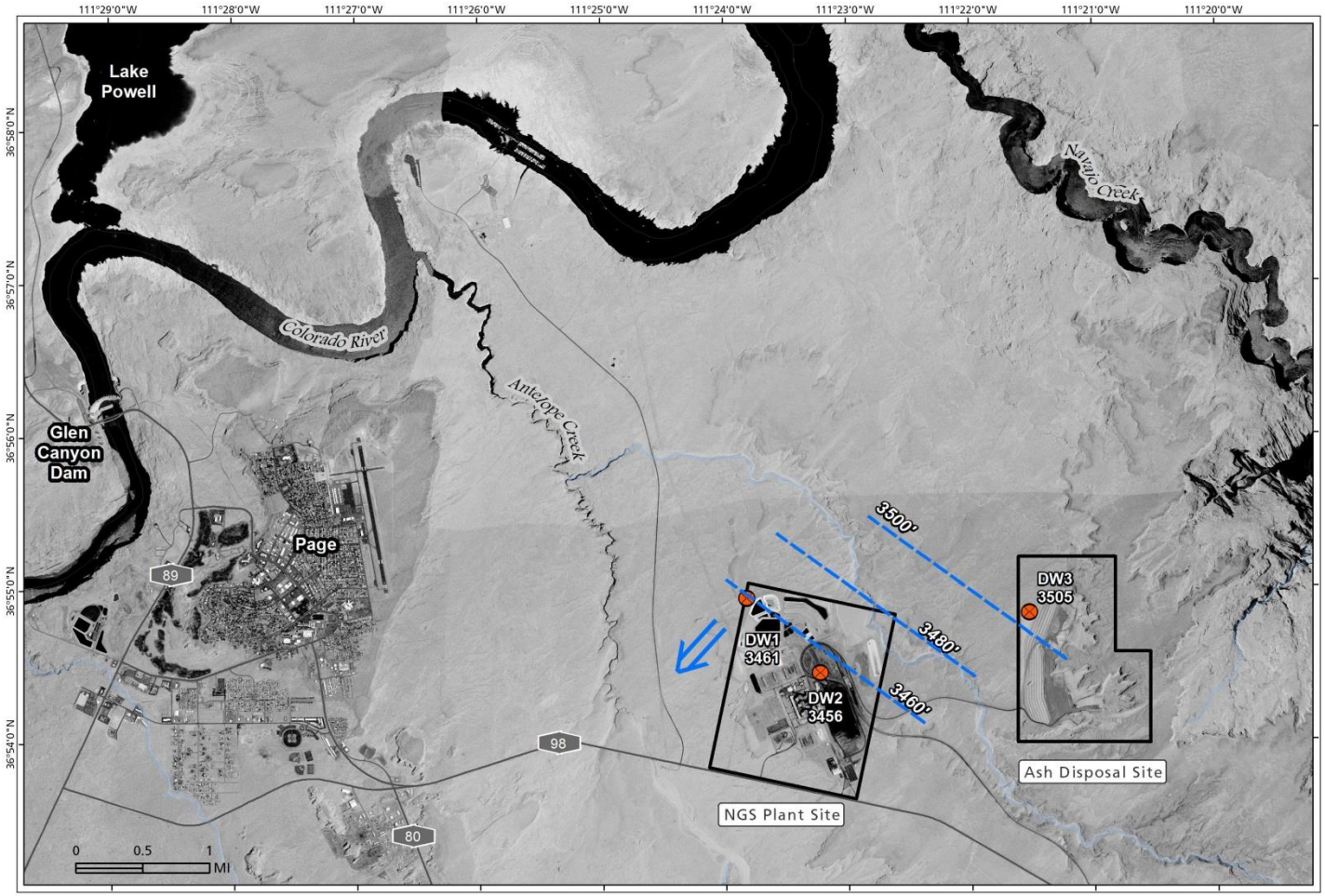
3460' Groundwater Elevation (20' interval)

Approximate Groundwater Flow Direction

Pre-Decisional Draft
for Planning and Discussion
Purposes Only

Figure 7b.
Groundwater Elevation and Flow Direction
Navajo Aquifer, November 1998

ESRI World Topographic Map Base - SRP C&GISS - ngs_groundwater_fig7b.mxd 10/8/2014



DW1
Navajo Sandstone Deep Monitor Well

3460'
Groundwater Elevation (20' interval)

Approximate Groundwater Flow Direction

Pre-Decisional Draft
for Planning and Discussion
Purposes Only

Figure 7c.
Groundwater Elevation and Flow Direction
Navajo Aquifer, November 2012

ESRI World Topographic Map Base - SRP C&GISS - ngs_groundwater_fig7c.mxd 10/8/2014

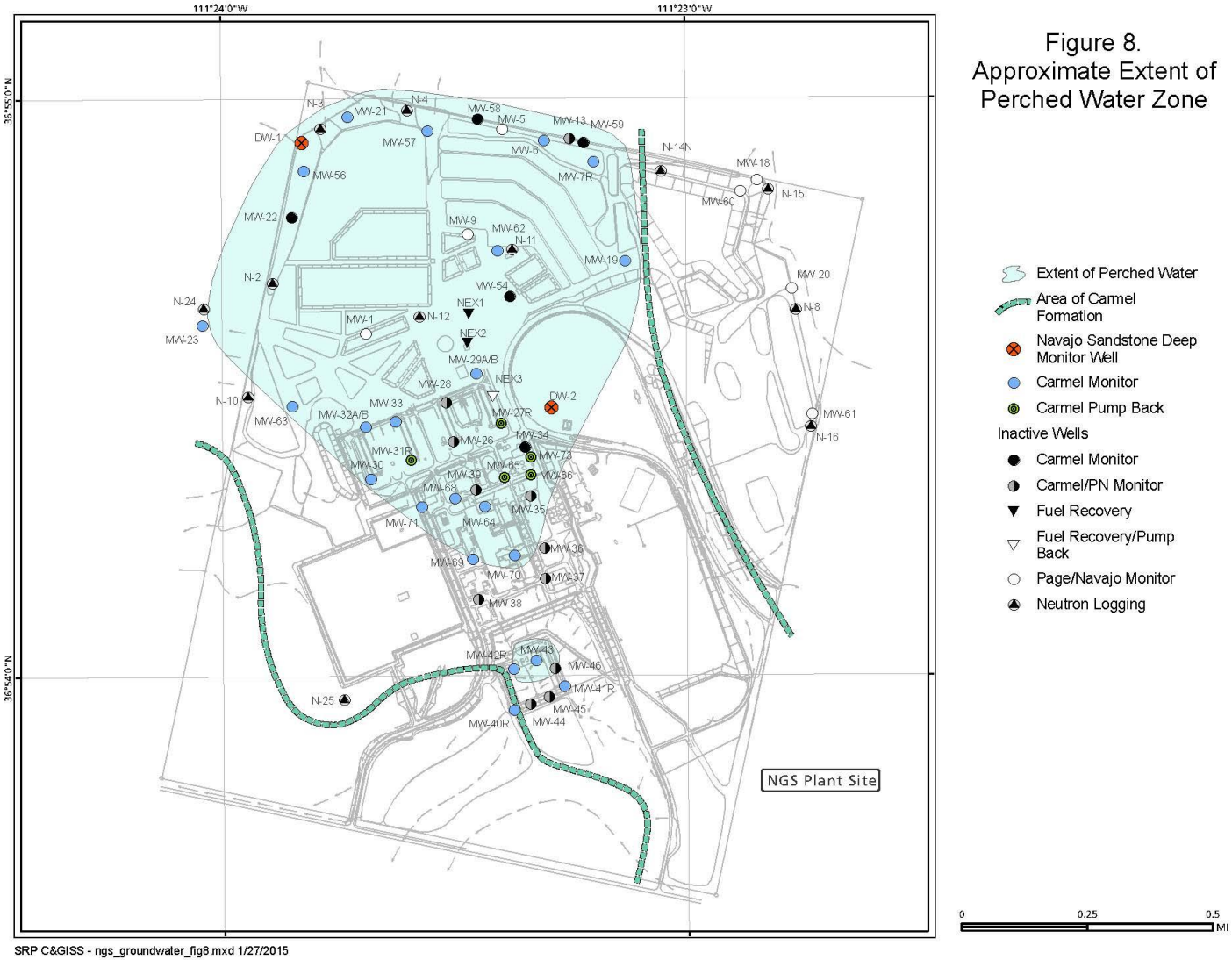
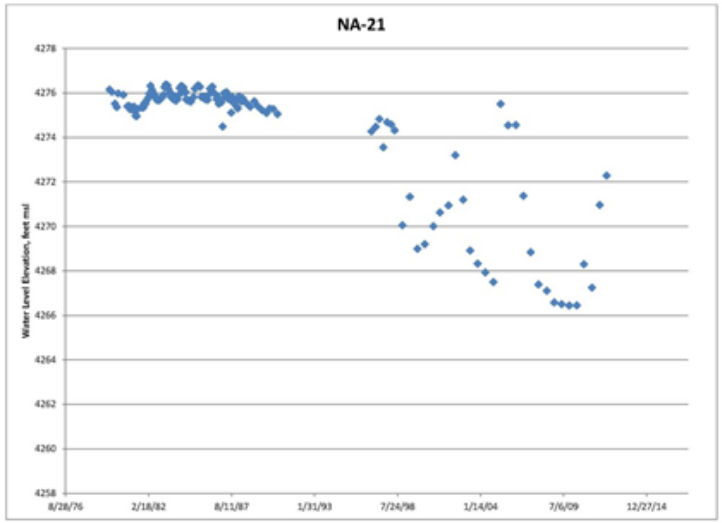
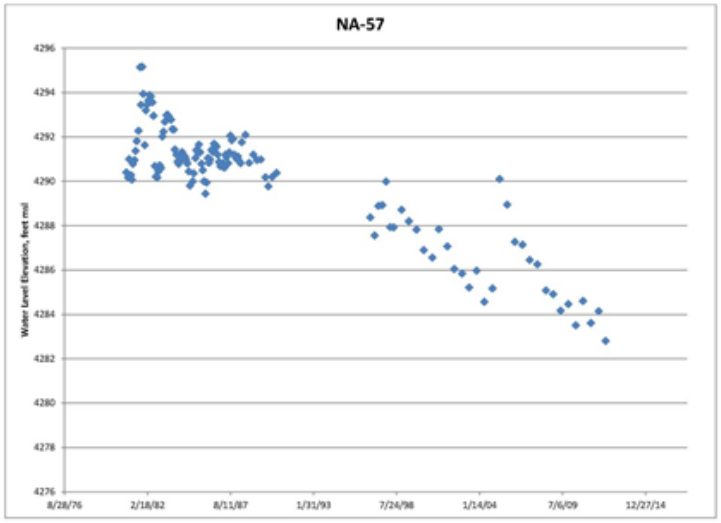


Figure 8.
Approximate Extent of
Perched Water Zone

Figure 9a. Water Level Hydrographs, Shallow Monitor Wells





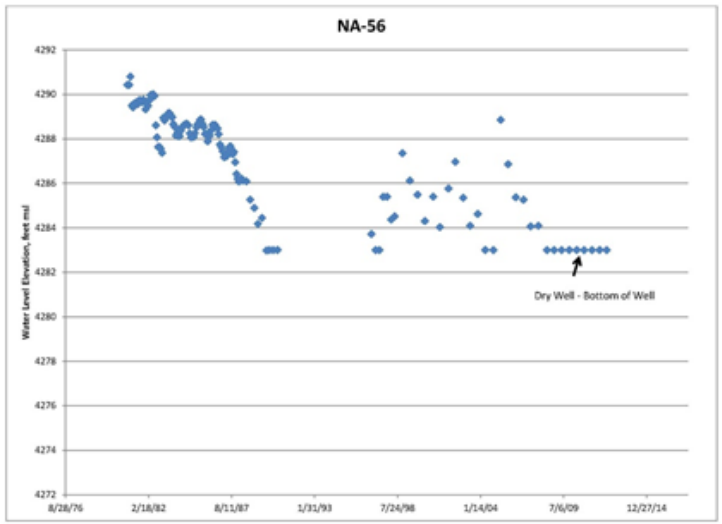
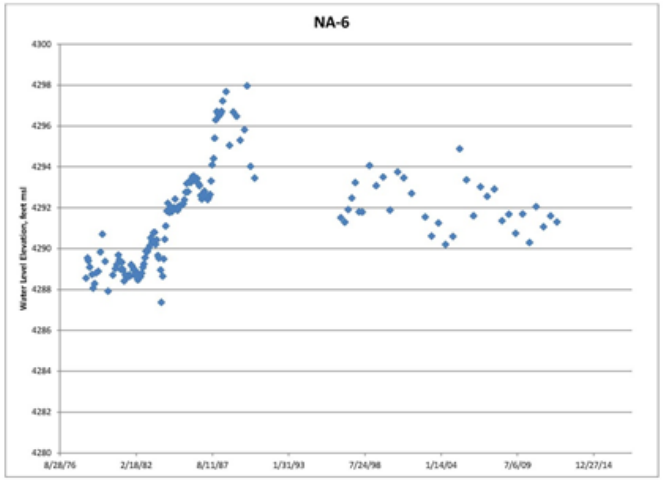
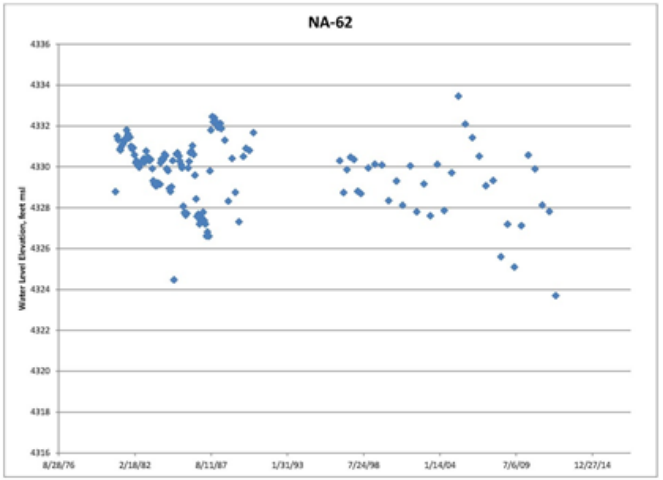


Figure 9b. Water Level Hydrographs, Shallow Monitor Wells





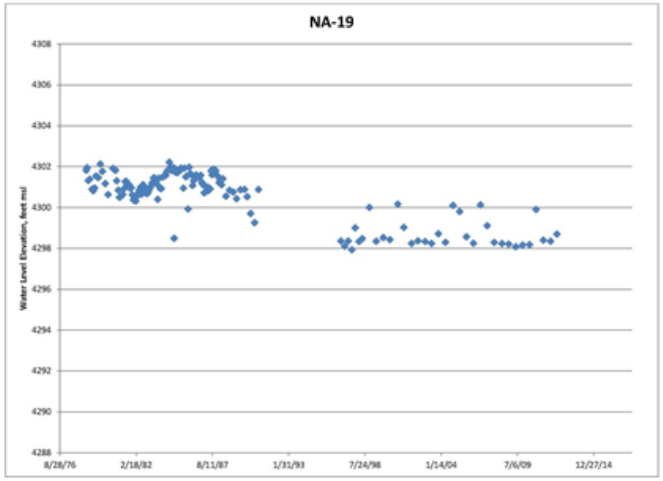
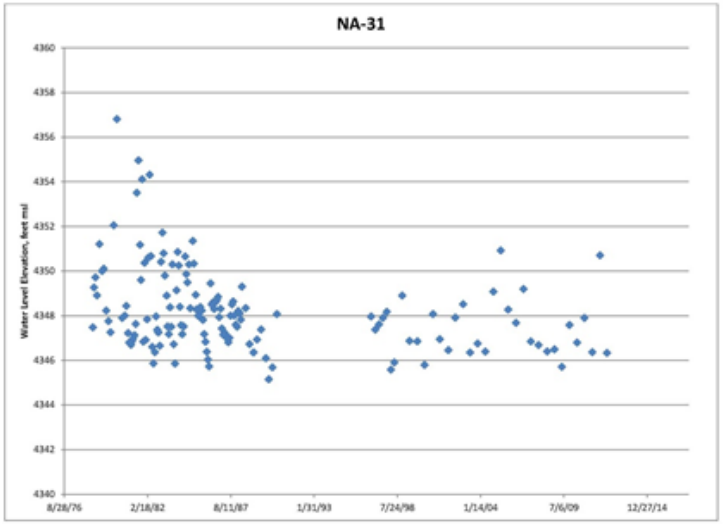
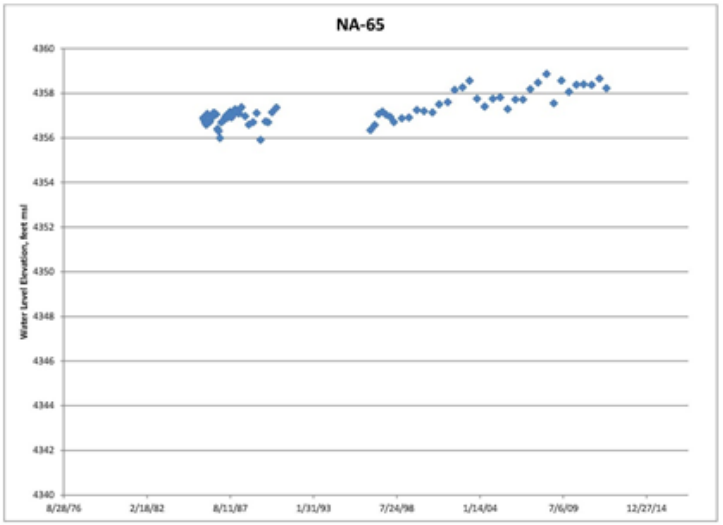
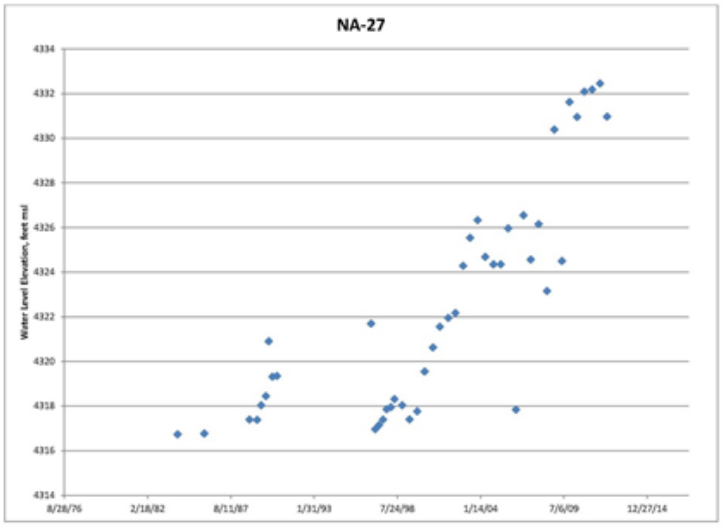


Figure 9c. Water Level Hydrographs, Shallow Monitor Wells







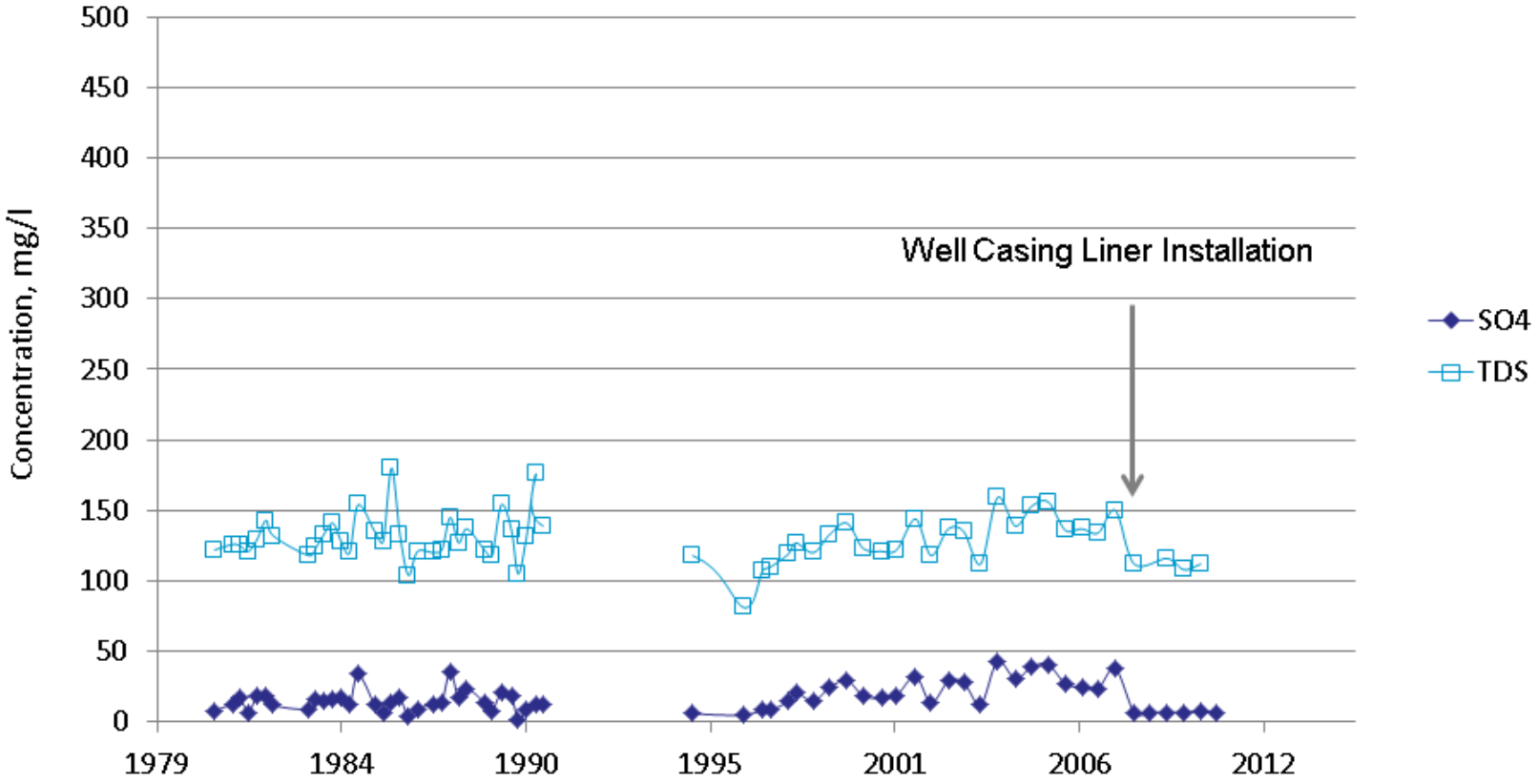


Figure 10. Total Dissolved Solids and Sulfate Concentrations, DW-1, 1982-2010

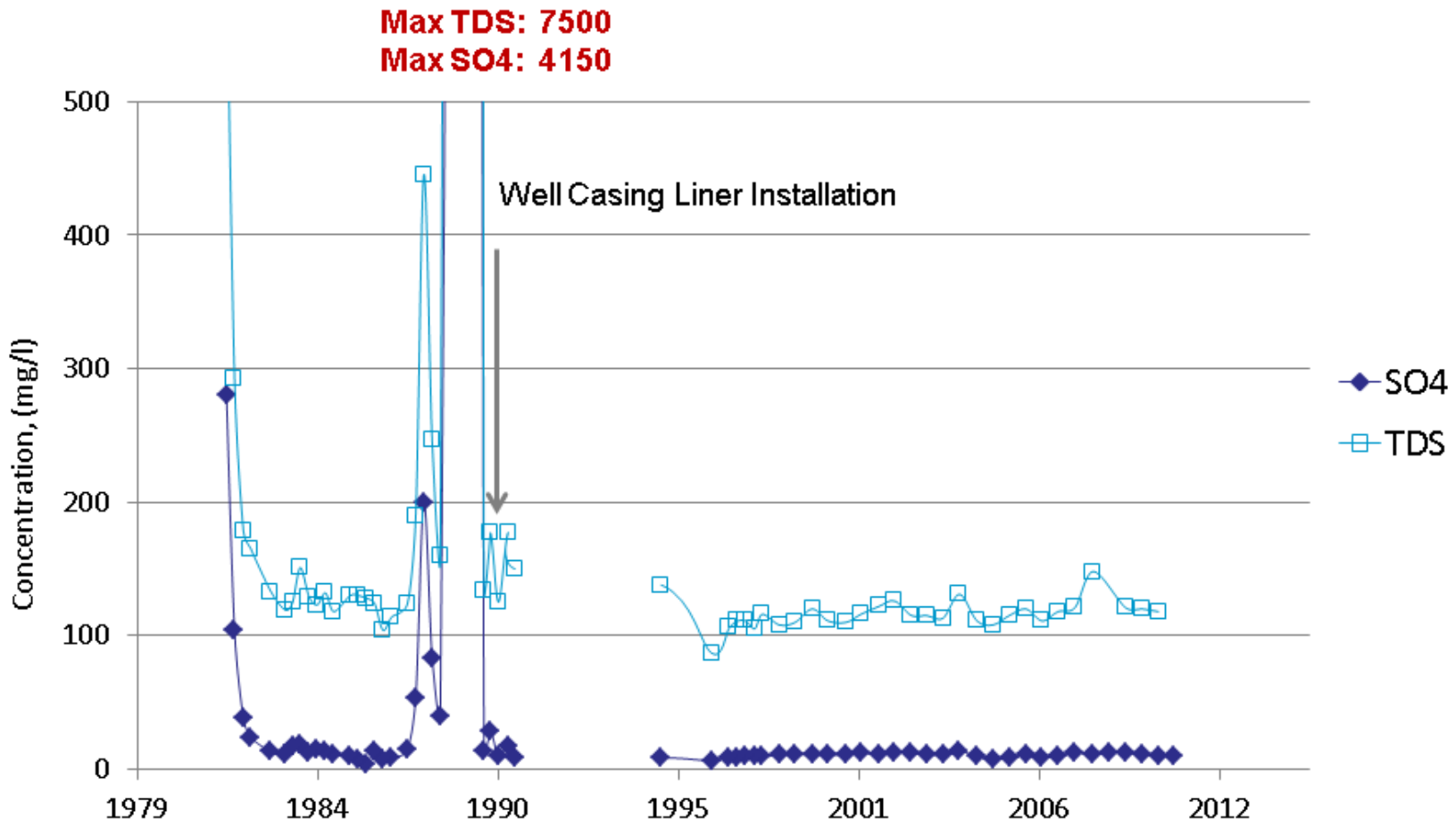


Figure 11. Total Dissolved Solids and Sulfate Concentrations, DW-2, 1982-2010

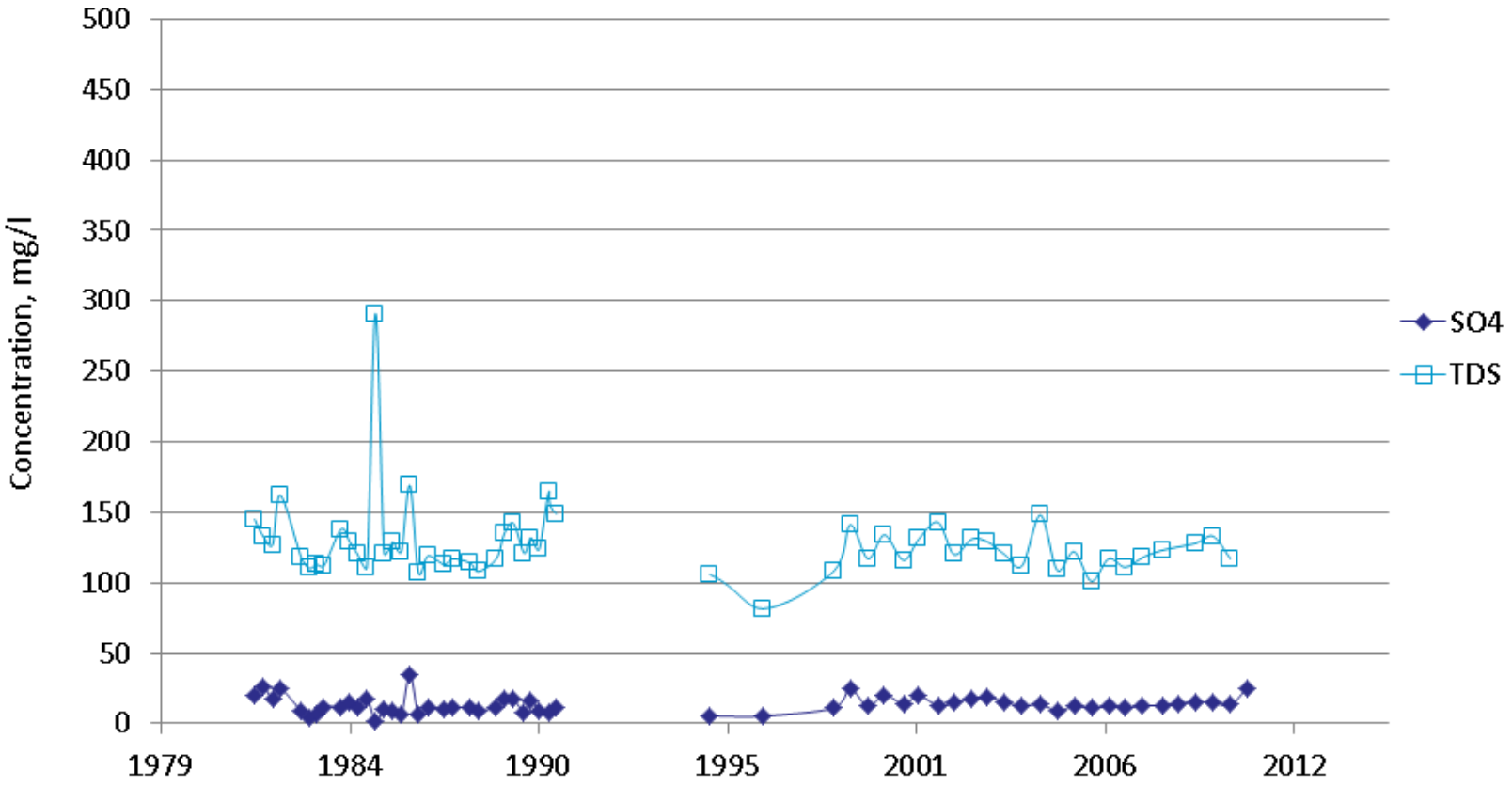


Figure 12. Total Dissolved Solids and Sulfate Concentrations, DW-3, 1982-2010

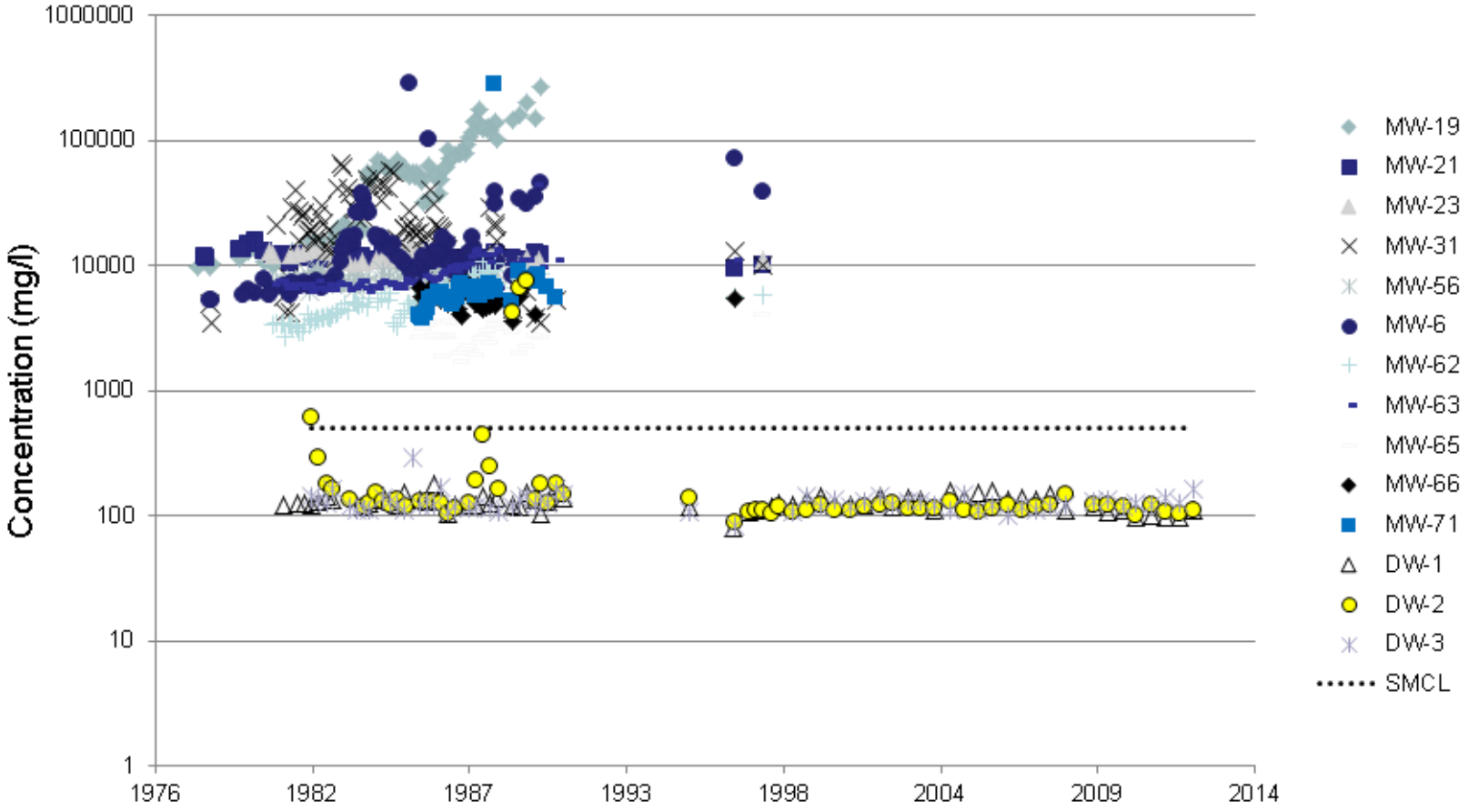


Figure 13. Total Dissolved Solids Concentrations, NGS Shallow and Deep Monitor Wells, 1978-2012

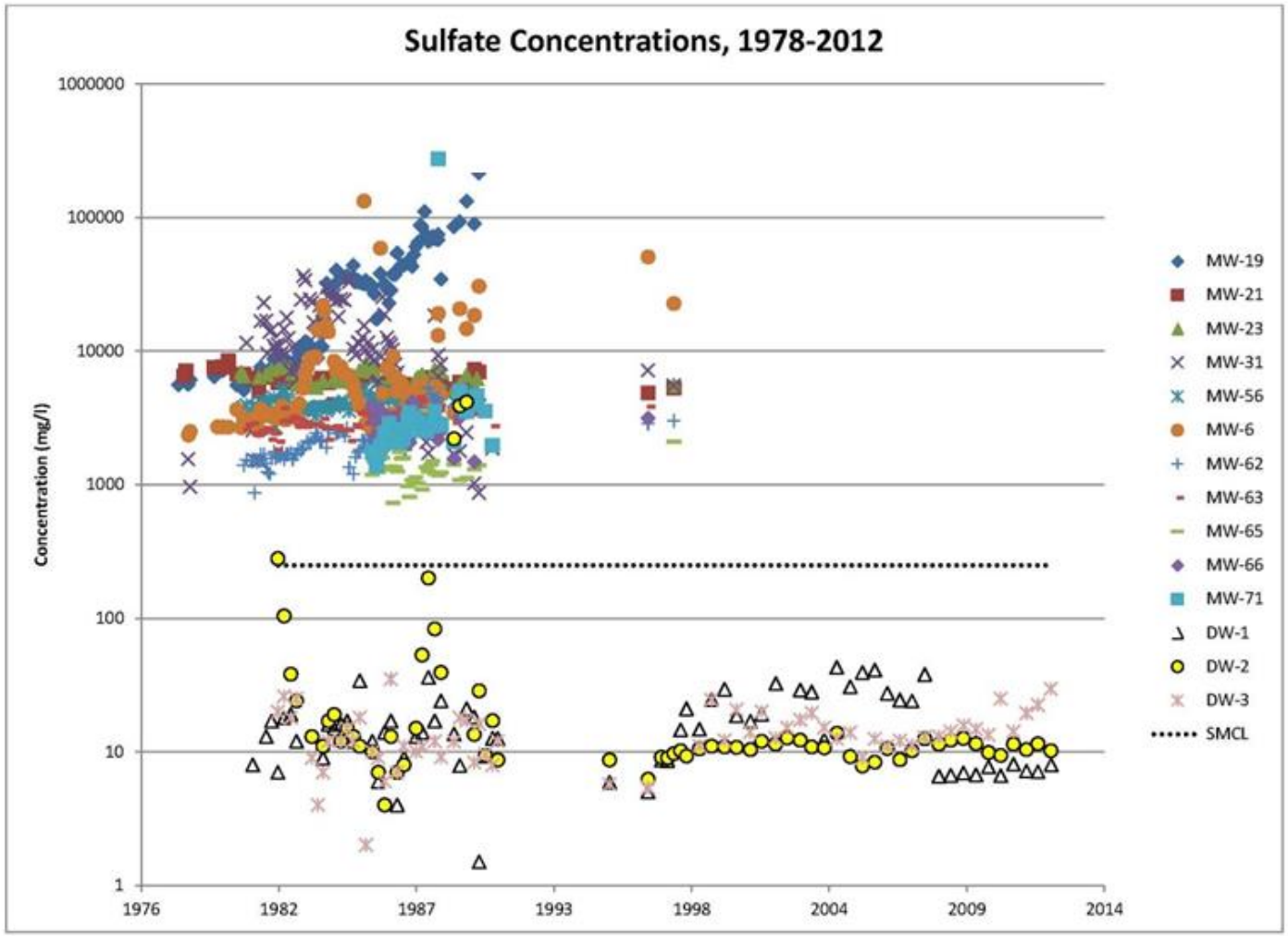


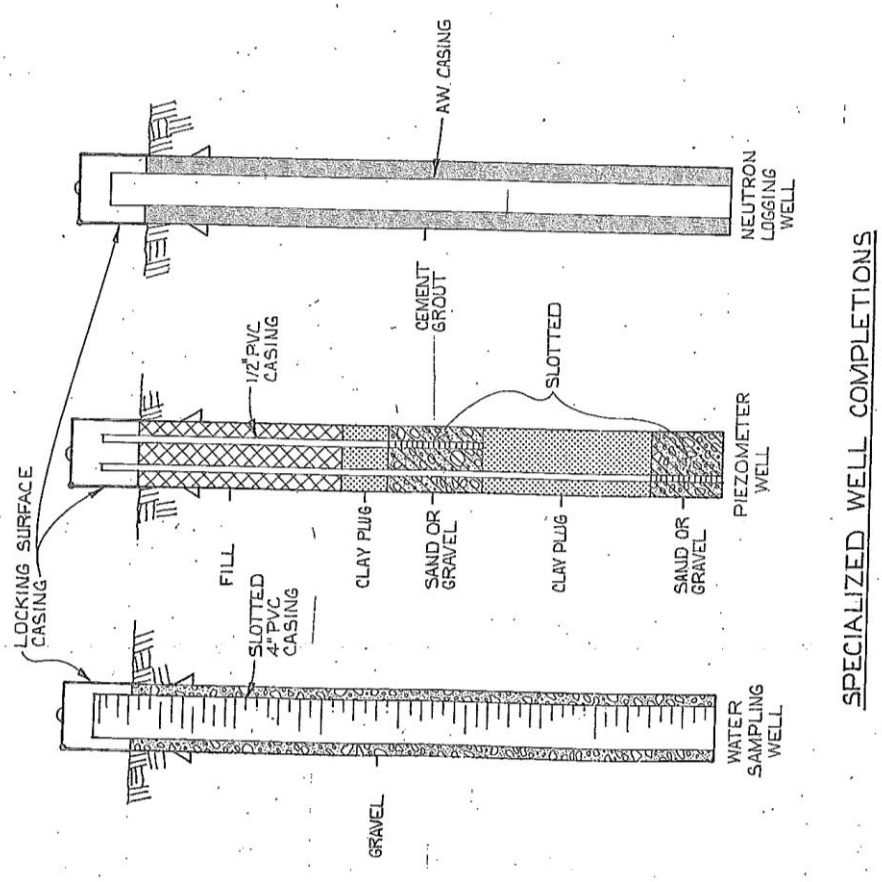
Figure 14. Sulfate Concentrations, NGS Shallow and Deep Monitor Wells, 1978-2012

Attachments

Attachment 1

General Well Construction Details for NGS Monitor Wells

General Well Construction Diagrams for NGS Shallow Monitor Wells and Neutron Wells



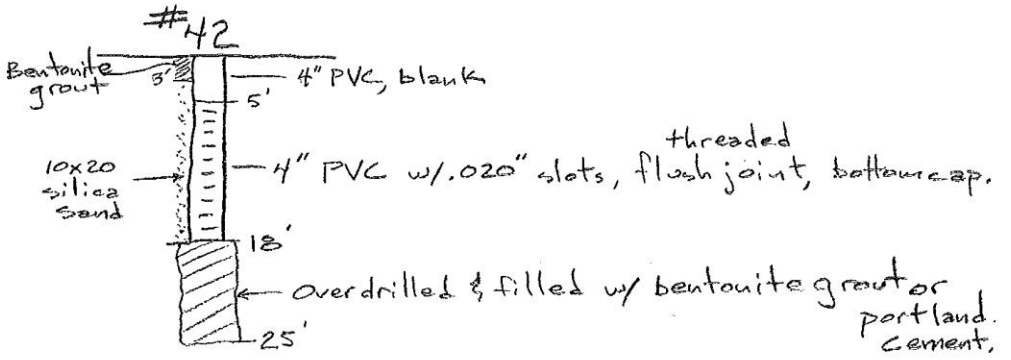
SPECIALIZED WELL COMPLETIONS

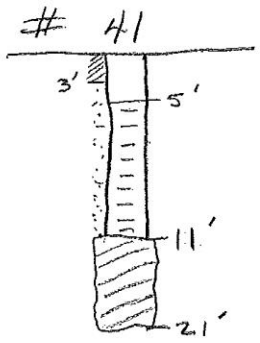
02-3850 R. 2/92

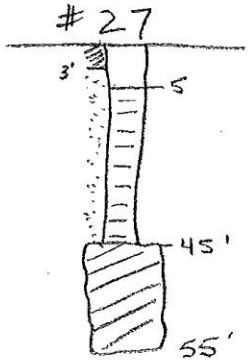
COMPUTATION SHEET

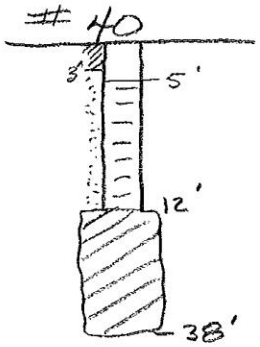
BY _____ DATE 2/13/14 SUBJECT NGS wells SHEET NO. ____ OF ____

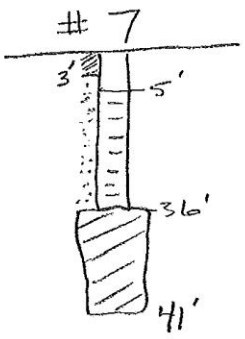
CHKD. BY W. Mills DATE _____ JOB NO. _____



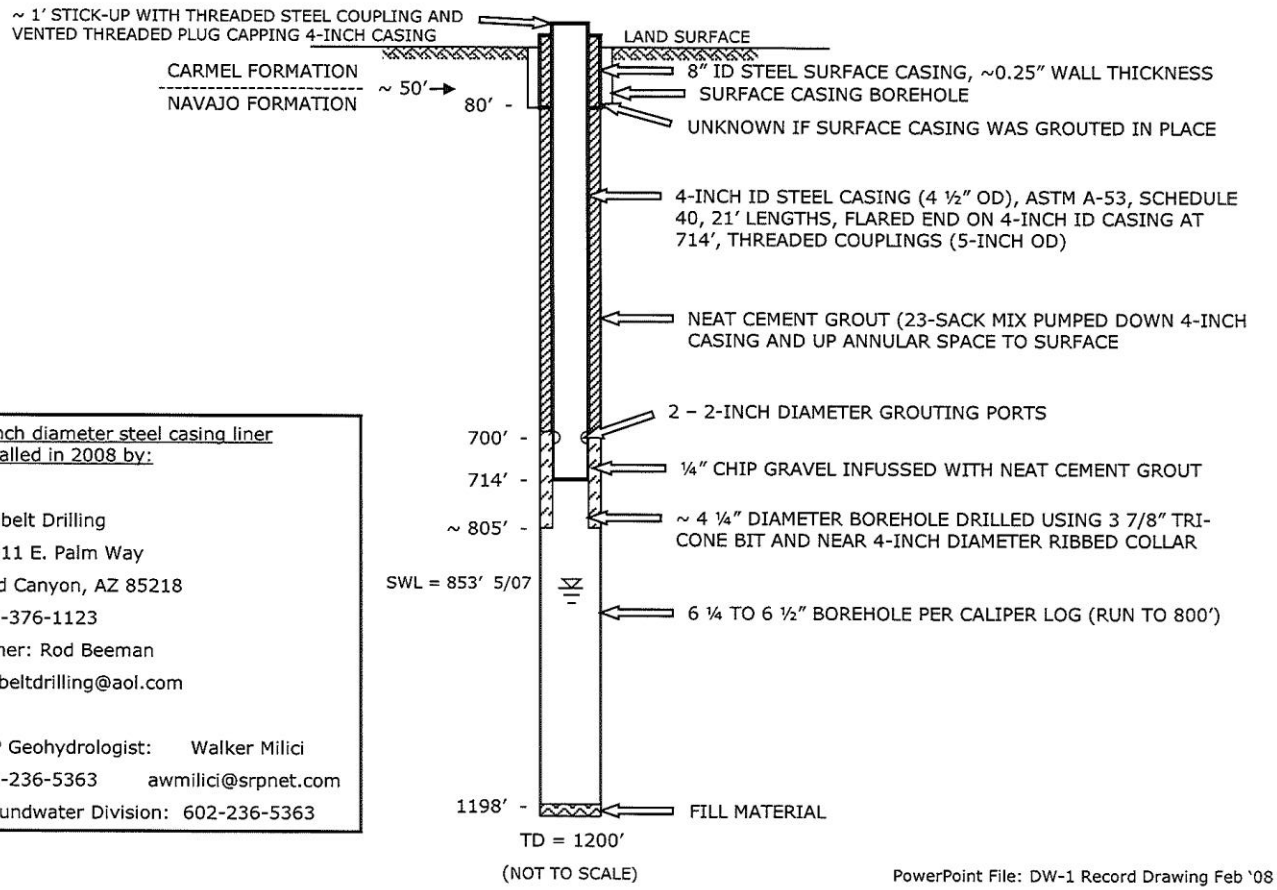








WELL CONSTRUCTION RECORD DRAWING FOR NGS WELL DW - 1



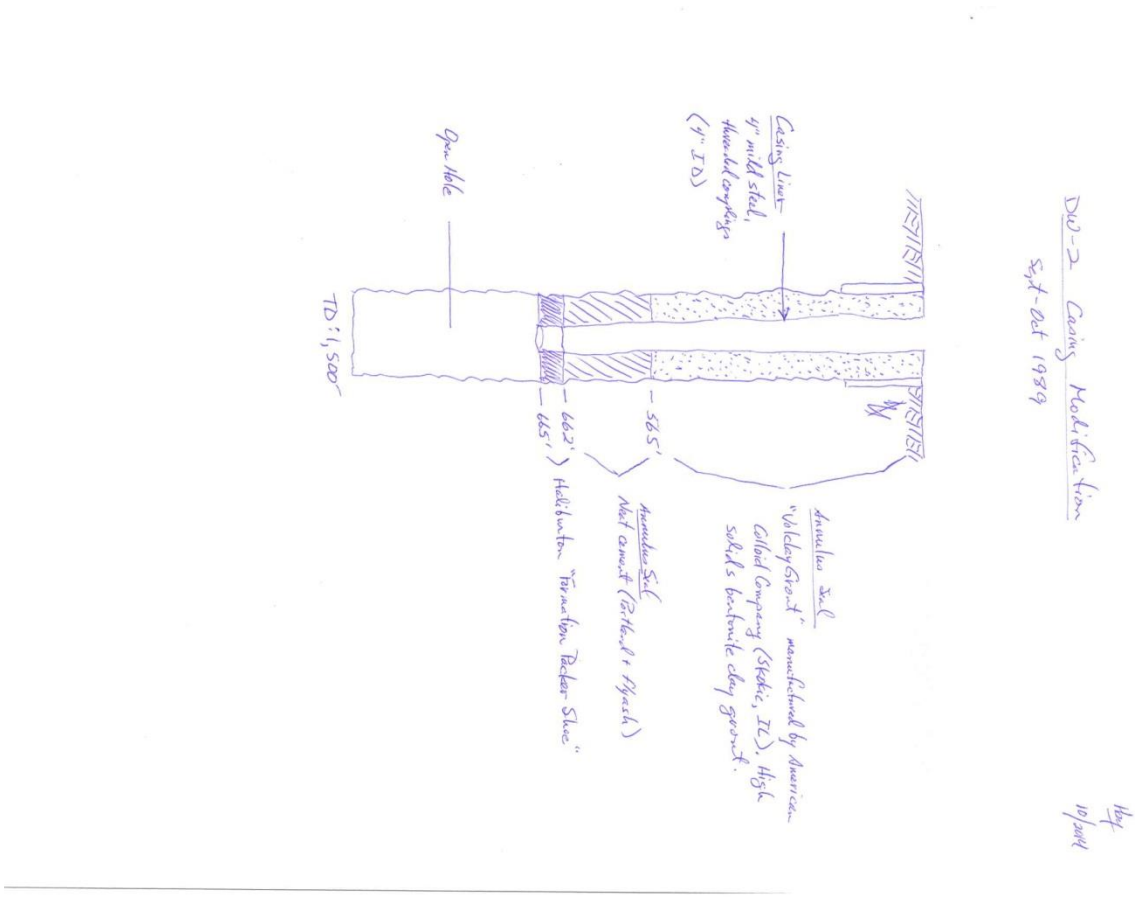
4-Inch diameter steel casing liner installed in 2008 by:

Sunbelt Drilling
11011 E. Palm Way
Gold Canyon, AZ 85218
602-376-1123
Owner: Rod Beeman
sunbeltdrilling@aol.com

SRP Geohydrologist: Walker Milici
602-236-5363 awmilici@srpnet.com
Groundwater Division: 602-236-5363

PowerPoint File: DW-1 Record Drawing Feb '08

Well Construction Details for NGS Deep Well DW-2



Attachment 2

NGS Process Water Pond History

(see GWPP for current status and description of best available control technology)

YEAR	POND	COMMENTS
1972	35-1,2,3,4,5 & 6	Constructed and placed in service
1974	45-1,2 & 3	Constructed and placed in service
1975	NE-1	Constructed and placed in service
	Brine Concentrator Unit 1	" " " "
1976	35-7,8 &9	Constructed and placed in service
	45-4,5 & 6	" " " "
	S-1 thru S-14	" " " "
	NE-2,3 & 4	" " " "
	Sludge Retention (SR-1&2)	" " " "
	35-6	Enlarged, placed in service
1979	45-1	Renamed 60-1
	45-2,3,4,5 & 6	Redesigned, combined and renamed 60-2
1981	Brine Concentrator Units 2&3	Constructed and placed in service
1982	S-1, 2 & 3	Modified and lined w/30mil liner
1985	NE-1	Reworked and lined w/100 ml liner, placed in service
	NE-SD (Solid Disposal Facility)	Constructed, lined w/100 ml liner, placed in service
	S-5	Relined w/100 ml liner
	NE-2,3 & 4	Removed from service - Abandoned
1986	Brine Concentrator U2 & 3	Redesigned to increase capacity
	35-1,2	Lined w/100 ml liner, placed in service
1987	60-1A & B	Redesigned from 60-1 & 2, lined w/100 ml liner

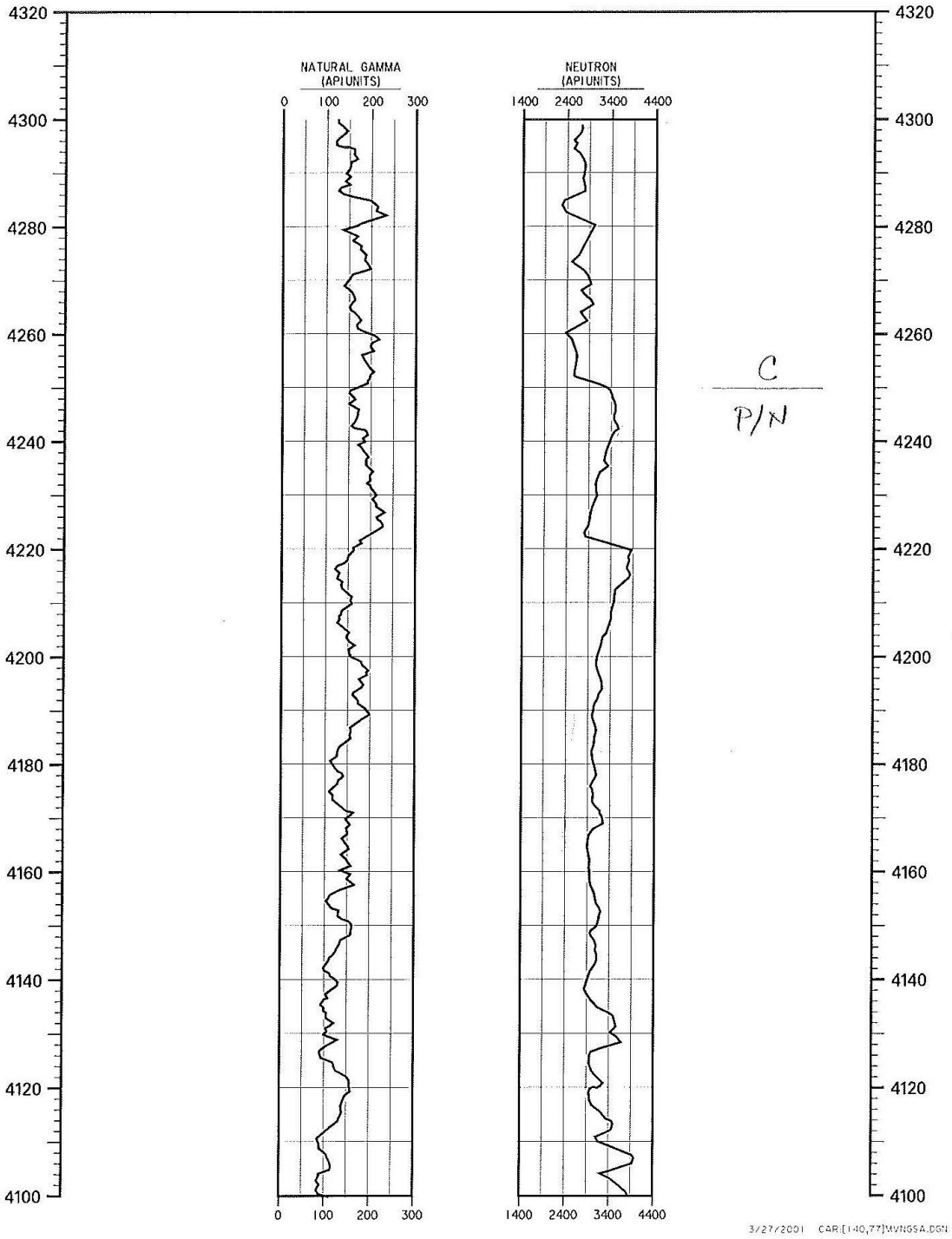
	Crystallizer	Constructed and placed in service
	60-2	Removed from service
	SR-1 & SR-2	Enlarged and lined w/soil cement
1988	S-13	Enlarged, relined w/100 ml liner, placed in service
1990	S-1, 2 & 3	Relined w/100 ml liner
1991	S-4,	Abandoned for construction of SD-2 & SD-3
	SD-2, SD-3	Constructed using double 100ml liner
Early 1990's	35-4,5,6,7,8,9	Removed from service
" "	S-5,6,7,8,9.10,11,12,14	Removed from service
Mid 1990's	SD-2	Placed in service

Attachment 3

Deep Well Neutron Logging Data

GEOPHYSICAL LOGS – DW-1

FEB. 10, 1997



GEOPHYSICAL LOGS – DW-2

FEB. 10, 1997

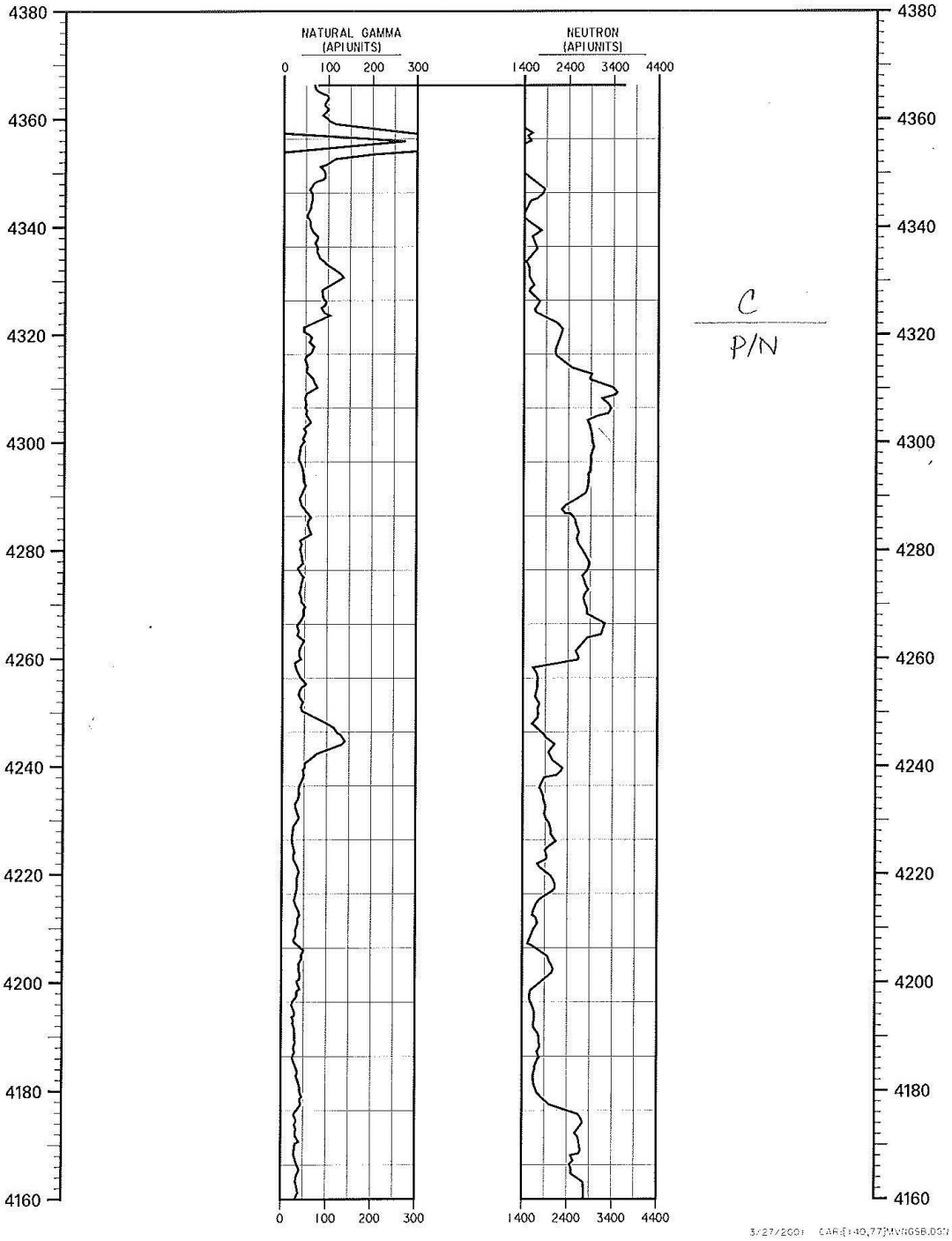
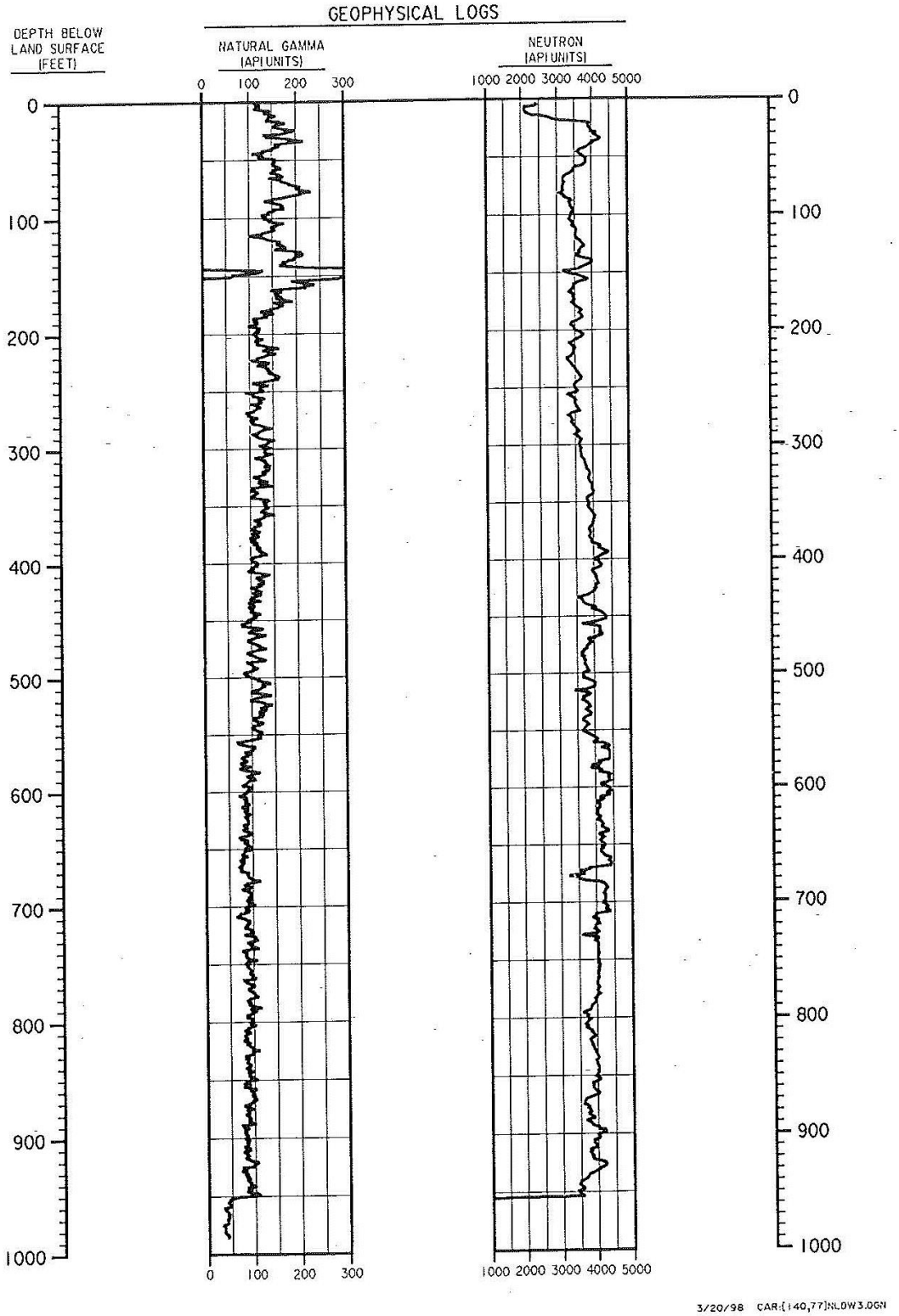


FIGURE 18:
NEUTRON LOG FOR DW-3 FEB. 1997



APPENDIX D

SOUTHERN TRANSMISSION SYSTEM:

APS POWER LINE CORRIDOR MANAGEMENT PLANS FOR VEGETATION MANAGEMENT 500-2 NAVAJO TO WESTWING POWER LINE

1. **Arizona State Land Department**
2. **Bureau of Land Management**
3. **US. National Forest**
4. **Navajo Nation (Herbicide Corridor Management Plan BAE)**

Arizona Public Service
300 North Granite Street
Prescott, AZ 86301
Phone: 928-443-6784

APS Power Line Corridor Management Plan for Vegetation Management
500-2 Navajo to Westwing Power Line

June 2, 2008

Arizona State Land Department

Prepared By:
Lisa Young
Natural Resource Specialist
Arizona Public Service

Table of Contents

INTRODUCTION

This Corridor Management Plan describes the procedures proposed by Arizona Public Service (APS) for the ongoing management of vegetation (utility vegetation management) along the 500-2 Navajo to Westwing 500kV transmission power line on Arizona State Land. The vegetation management of this power line will include an initial corridor clearing (referred to henceforth as 'initial clearing'), ongoing hazard vegetation pruning or removal, and follow-up routine vegetation maintenance scheduled cyclically approximately every five years. This corridor management plan describes the proposed actions for these maintenance activities and the clearance standards for the maintenance of this power line.

Vegetation maintenance serves four main purposes: 1) provides reliable, uninterrupted service to customers; 2) provides safe and efficient transmission of power along existing lines; 3) provides safe and reasonable access to the lines and structures for inspection and maintenance; and 4) provides protection against wildfires by reducing the potential for fire ignition from vegetation in around the power lines, and reduces fuel load under the lines which reduces effects of existing fires damaging structures or causing a power fault in the lines. Failure to address vegetation clearance and fuel hazards could result in wildfires, major power outages, and injury to life or property. Additionally, new federal energy regulations mandate vegetation inspections and treatment to maintain lines in safe and reliable operating conditions (NERC Reliability Standard FAC-003-1). These new federal regulations require mandatory compliance to reliability standards dealing with various aspects of the planning and operation of the power system, including vegetation maintenance. The North American Electric Reliability Corp. (NERC) monitors utility compliance with these standards and may impose fines, restrictions, or directives for corrective action to utilities not in compliance. Fines are $1,000 to $1 million a day if vegetation violates the mandatory standards. It goes without saying that APS will do all they can to avoid fines of this nature. Thus, because of the reasons listed here, APS proposes to maintain vegetation along their 500-2 power line.

OPERATIONAL PROCEDURES

GENERAL DESCRIPTION

The 500-2 power line is a 500 kV transmission line that begins at Navajo Generating Plant east of Page, AZ, heads south-west from there to just north-east of Ashfork, AZ where it bends and continues south to terminate at the Westwing Substation in Phoenix, AZ. This transmission line consists of two parallel, high-voltage transmission lines with the eastern line called the West Wing Line and the western line called the Moenkopi Line. These two lines are referred to collectively as the 500-2 power line. The total power line distance in Arizona for the 500-2 line is 256.9 miles and occurs across various land owners as shown in Table 1. Maintenance activities on other land ownership will be

coordinated with that land owner and will not be addressed in this corridor management plan. The portions of line on State Land is 46.7 miles long.

Table 1: Land Ownership for the 345-1 Power Line

Land Ownership	**Distance in Miles**
Bureau of Land Management	27.0
Bureau of Reclamation	0.7
Kaibab National Forest	27.0
Navajo Indian Reservation	96.1
Prescott National Forest	37.9
Private Land	21.4
State Trust Land	46.7
Total Miles	**256.9**

The proposed vegetation management is in compliance with the State Land special use permits. There are three special use permits for the 500-2 transmission line on State Land: permit numbers 14-26217, 14-26215, and 14-26216. All permits have a Right-of-Way (ROW) width of 330 feet wide, were granted on October 20, 1976 and expire on October 19, 2026. The total acres of power line ROW on State Land is 1,868 total acres (330 ft. ROW x 46.7 miles long x 5280 feet per mile/ 43,560). Refer to Appendix 2 for a list of the township, range, and sections the line crosses through on State Land, and Figure 1 and Figure 2 for maps of the power line (large portions of the power line with no State Land are excluded from the maps).

Figure 1: Map of 500-2 Power Line North End

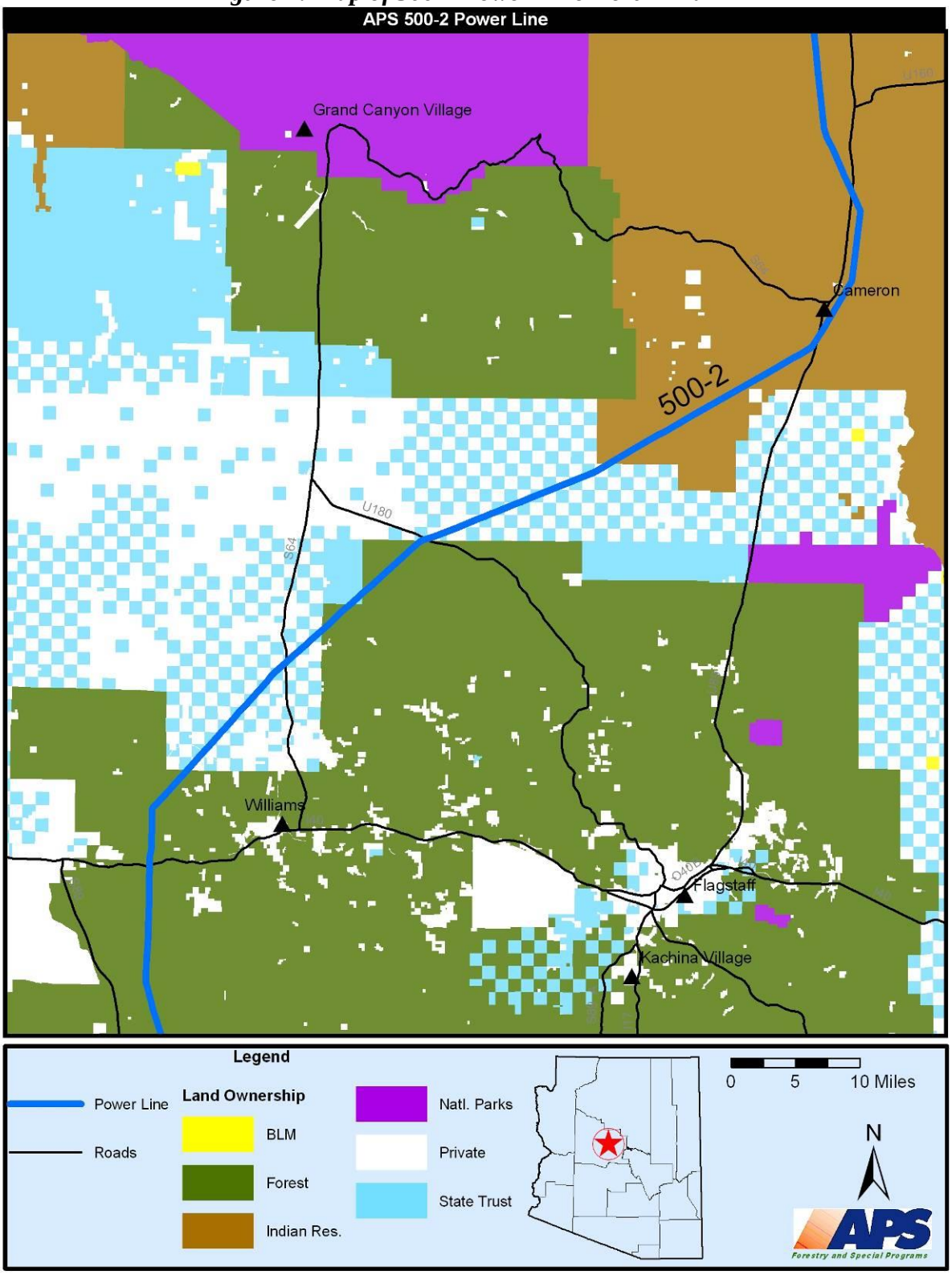
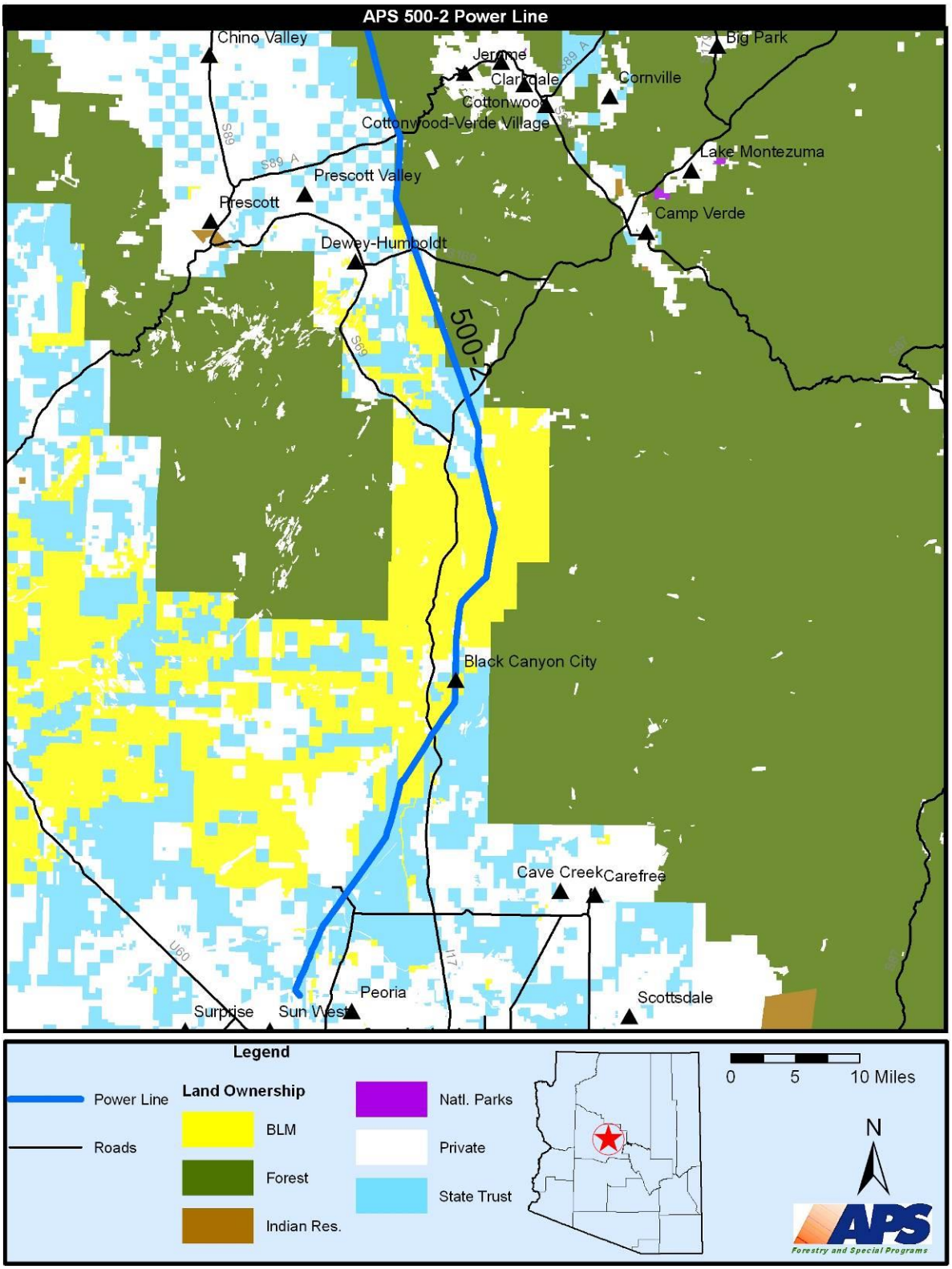


Figure 2: Map of 500-2 Power Line South End



VEGETATION CLEARING STANDARD

APS proposes to clear vegetation throughout the 330 foot wide 500-2 power line ROW on State Land. This would include removing all woody vegetation throughout the corridor under and between the power line wires and within a 40 foot radial distance around each tower, and the removal of tall growing vegetation and some low growing vegetation outside the wires out to the permitted ROW edge. This vegetation clearing could potentially impact 1,868 acres on State Land, but this is likely an overestimate because canyons and other areas where the line is high above vegetation would not be treated. No vegetation would be treated outside of the permitted ROW.

It should be noted that multiple saguaros require removal towards the southern end of the power line. APS will commit to coordinating with the Arizona Department of Agriculture in finding salvagers to move the saguaros off sight. If salvagers are not found in a timely manner, APS will remove the saguaros using hand crews or the mower.

APS proposes to use manual and mechanical methods as described below for initial clearing and ongoing vegetation maintenance. Hazard vegetation treatment may also be required (see hazard vegetation definition Appendix 1). As the vegetation management prescription is followed, the corridor should be converted to low growing plant communities that do not interfere with overhead power lines, pose a fire hazard, or hamper access.

TREATMENT METHODS

The vegetation maintenance of the 500-2 power line corridor will include three types of treatment methods which are summarized below. Treatment methods for these are described in detail below. All work is conducted Monday through Friday during daytime hours.

1. **Initial Vegetation Clearing:** The initial clearing of the power line will involve removing woody vegetation within the 330 foot power line ROW. Initial clearing is anticipated to begin in May 2008 and would continue until work is complete (likely by December 2008). The initial clearing would include mechanical and manual methods of vegetation treatment. Manual methods could involve from 40 to 80 line clearance tree workers spread out along the power lines. This type of clearing has not been done on this line for a long time, and this initial clearing will be conducted to bring the corridor up to vegetation clearance standards. The Routine Vegetation Maintenance will be conducted following this to maintain these clearance standards.

2. **Routine Vegetation Maintenance:** Following the initial clearing of the 500-2 power line, the corridor will require continual maintenance to address any new growth of limbs or woody vegetation that encroaches within the corridor. This

routine maintenance will not widen the corridor beyond the permitted ROW and would be conducted using the same methods as the initial clearing. For the 500-2 line, this ongoing maintenance will be scheduled every 5 years following the initial clearing.

3. **Hazard Vegetation Removal and Pruning:** Vegetation posing a hazard (see hazard vegetation definition Appendix 1) to the power line or structures may be removed on an ongoing basis at any time. Hazard vegetation may also be addressed during the initial clearing and routine maintenance cycle. Hazard vegetation is removed or pruned as soon as possible after identification. Hazard vegetation is treated using 1 to 2 hand crews with 2 to 3 tree workers per crew.

Access Routes

APS would travel to and from the power line ROW using existing established roads and within the power line ROW. If established roads are not available for a particular area, work would be conducted by hand crews for that area and the crews would hike in from the nearest access point. Should a previously closed road be required for temporary access, APS would coordinate with the State Land to determine if temporarily opening the road would be possible.

Mechanical Vegetation Removal

Mechanical methods of vegetation removal within ROW corridors involve the use of a cutting device on an arm mounted on a tractor with tracks or rubber tires (called a mower) that cuts and masticates vegetation. The mower method of clearing vegetation is quick and cost effective in many areas and mulches the vegetation into small chipped pieces. This method is APS's preferred method in all areas where the mower can access the ROW. Mowers typically are not able to operate at slopes of greater than 30%, so areas with slopes greater than 30% will be treated by hand crews. Mechanical methods would also not be used in any cultural sites or other areas identified by State Land for mower avoidance. In these areas, manual methods will be used.

The mower is operated by one driver and one grounds-person. The grounds-person directs the mower and may operate a chainsaw to cut trees that the mower is unable to access. Hand crews may also follow after the mower to clean up, scatter debris, and prune or remove trees that the mower could not access. All vegetation is mulched by the mower and left on site in the corridor piled no higher than four inches.

Manual Vegetation Removal

In areas where the mower can not access the power line or where there are cultural or resource concerns, manual hand crews will be used to remove and prune vegetation within the power line ROW. Hand crews may also be used in areas where mechanical methods are used to clear around towers or in other areas where the mower can not access, or to aid in spreading mulched vegetation throughout the ROW. Hand crews

would also be used for hazard vegetation treatments. The hand crews are trained in utility tree work and would use hand tools (chain saws, hand saws, rope) to cut branches and trunks of vegetation and then lop and scatter the limbs and logs within the ROW as described below under "Vegetation Disposal".

Vegetation Disposal

Vegetation maintenance involves two vegetation disposal treatments. Stumps from tree removal are cut within 6 to 12 inches of the ground or if possible stumps are cut flush with the ground and no limbs and logs are placed within 25 feet of the high mark of streams or other bodies of water and all areas with the potential for flowing water (culverts, ditches, washes, etc.) are kept free of limbs, logs, and debris from vegetation removal operations. The treatments and conditions where they apply appear below:

1. Lop and Scatter: This method will be used in areas where manual treatments are used.
    - Limbs are lopped and scattered throughout the immediate area in a manner such that debris lies within 18-24" of the ground.
    - The logs are cut to manageable lengths of eight feet or less and left on site off of access routes

2. Vegetation mulched: This method will be used in areas where mechanical treatments are used.
    - Limbs and logs are masticated by the mower and spread across the ROW no deeper than 4 inches deep.
    - Any vegetation that the mower can not treat would be treated using manual methods and disposed of as discussed in number 1 above.

APPENDIX 1: DEFINITIONS

Arc: The flow of electricity across a gap (through the air) from one conductor to another or to a grounded object. Arcing potential is evaluated by using accepted industry standards such as the National Electric Safety Code.

Conductor: A wire, combination of wires, bus bar, rod or tube suitable for carrying an electrical current. When describing a power line, may often be interchangeably referred to as a power line, line, phase, circuit, wire, cable, or primary. Any material that allows electricity to be carried through it.

Energized: Synonymous to "live" or "hot".

Energized Conductor: An electrically energized wire or other object that is conducting electricity.

Flashover: An unintended electrical discharge to ground or another phase. Flashovers can occur between two conductors, across insulators to ground or equipment bushings to ground. Caused by placing a voltage across the air space that results in the ionization of the air space.

Hazard Vegetation: Hazard vegetation is a live or dead standing tree or vegetation having defects, singly or combined, in the roots, butt, bole, or limbs, which predispose it to imminent mechanical failure to the whole or part of a utility line, pole, or tower. The tree or vegetation must be located such that a failure of the tree or vegetation (or any part of the tree or vegetation) has a probability of causing damage to the utility line, pole, or tower. A "defect" is an injury or disease that seriously weakens the stems, roots, or branches of the tree or vegetation, predisposing it to fail (e.g., broken branches, split top) to continue standing. "Imminent" implies that damage resulting to the utility line, pole, or tower from the tree or vegetation could occur at any time. This definition applies to any vegetation that poses an immediate threat to a utility line. Hazard vegetation can include vegetation with arc potential (see Arc definition). Trees or vegetation with arc potential may be healthy with no defects predisposing them to imminent mechanical failure, but if vegetation is within arcing potential from a transmission or distribution line, it may pose a hazard. In order to eliminate hazards, pruning or removal of the hazard would be necessary.

Integrated Vegetation Management (IVM): A system of managing plant communities in which compatible and incompatible vegetation is identified, action thresholds are considered, control methods are evaluated, and selective controls are implemented to achieve a specific objective. Choice of control methods is based on effectiveness, environmental impact, site characteristics, safety, security, and economics.

Kilovolt (kV): 1,000 volts.

Routine Vegetation Maintenance: The process of identifying and removing or pruning vegetation within the power line corridor for the purpose of providing safe, efficient, and reliable delivery of electricity. Proper clearance must be maintained at all times between power lines, trees, the ground, buildings, etc., taking into consideration a reasonable re-entry time between clearance cycles.

Span: The horizontal distance between two adjacent power poles.

Transmission Power Line: Heavy wires that carry large amounts of electricity at very high voltages over long distances from a generating station to a substation. Transmission voltages range from 69,000 to 500,000 volts (69 – 500kV).

Utility Vegetation Management: The process of managing vegetation surrounding utility lines for the purpose of providing safe, efficient and reliable delivery of electricity while minimizing vegetation related fires. Vegetation management includes routine vegetation maintenance, removing and pruning hazard vegetation, vegetation control around poles, structures, and other electric facilities. Vegetation management involves manual and mechanical treatment of vegetation, pre- and post inspections of vegetation, and disposal of vegetation.

APPENDIX 2: LEGAL DESCRIPTION OF 500-2 ON STATE LAND

Township	Range	Section	Township	Range	Section	Township	Range	Section
26.0N	06.0E	4	23.0N	01.0E	14	06.0N	01.0E	13
26.0N	06.0E	3	23.0N	01.0E	13	06.0N	01.0E	23
26.0N	05.0E	12	23.0N	01.0E	22	06.0N	01.0E	27
26.0N	06.0E	7	23.0N	01.0E	23	06.0N	01.0E	26
26.0N	06.0E	8	23.0N	01.0E	28	06.0N	01.0E	33
26.0N	06.0E	9	23.0N	01.0E	27	06.0N	01.0E	34
26.0N	05.0E	15	23.0N	01.0E	32	05.0N	01.0E	4
26.0N	05.0E	14	23.0N	01.0E	33	05.0N	01.0E	4
26.0N	05.0E	13	15.0N	01.0E	1	05.0N	01.0E	4
26.0N	05.0E	19	15.0N	01.0E	12	05.0N	01.0E	4
26.0N	05.0E	20	15.0N	02.0E	7	05.0N	01.0E	5
26.0N	05.0E	21	15.0N	02.0E	7	05.0N	01.0E	8
26.0N	05.0E	22	12.0N	02.0E	14	05.0N	01.0E	17
26.0N	05.0E	30	12.0N	02.0E	23	05.0N	01.0E	17
26.0N	04.0E	32	12.0N	02.0E	24	05.0N	01.0E	17
26.0N	04.0E	33	12.0N	02.0E	25	05.0N	01.0E	18
24.0N	03.0E	6	12.0N	02.0E	36	05.0N	01.0E	19
24.0N	03.0E	7	11.0N	02.0E	1	05.0N	01.0E	30
25.0N	03.0E	28	11.0N	03.0E	6	05.0N	01.0W	25
25.0N	03.0E	27	11.0N	03.0E	18	05.0N	01.0W	36
25.0N	03.0E	27	11.0N	03.0E	18	14.0N	02.0E	29
24.0N	02.0E	11	11.0N	03.0E	19	14.0N	02.0E	32
24.0N	02.0E	12	11.0N	03.0E	30	13.0N	02.0E	6
24.0N	03.0E	7	11.0N	03.0E	30	13.0N	02.0E	7
24.0N	02.0E	15	09.0N	02.0E	25	13.0N	02.0E	8
24.0N	02.0E	14	07.0N	02.0E	20	13.0N	02.0E	8
24.0N	02.0E	21	07.0N	02.0E	19	09.0N	02.0E	25
24.0N	02.0E	22	07.0N	02.0E	20	09.0N	02.0E	36
24.0N	02.0E	29	07.0N	02.0E	30	09.0N	02.0E	36
24.0N	02.0E	28	07.0N	02.0E	31	08.0N	02.0E	12
24.0N	02.0E	31	06.0N	02.0E	6	08.0N	02.0E	13
24.0N	02.0E	32	06.0N	02.0E	7	08.0N	02.0E	26
23.0N	01.0E	1	06.0N	01.0E	12	08.0N	02.0E	34
23.0N	02.0E	6	06.0N	01.0E	14	07.0N	02.0E	3
23.0N	01.0E	12						

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Phoenix District
Hassayampa Field Office
Agua Fria National Monument
21605 North 7th Avenue
Phoenix, Arizona 85027
www.blm.gov/az

November 14, 2008

In Reply Refer To:
2800 (AZ-210/230)
AZA-6121, AZA-27240

CERTIFIED MAIL – RETURN RECEIPT REQUESTED NO. 7006 3450 0002 4910 1136

Arizona Public Service
300 North Granite Street
Prescott, AZ 86301

Re: BLM R/W Grants AZA-6121 and AZA-27240
Navajo to Westwing Twin 500kV Power Line

AUTHORIZATION—RIGHT-OF-WAY OPERATION AND MAINTENANCE

This is in response to your October 2, 2008, Corridor Management Plan concerning vegetation maintenance under rights-of-way grants AZA-6121 and AZA-27240.

Based on the information presented in the Plan and your meetings with interdisciplinary Bureau of Land Management (BLM) staff regarding the proposed vegetation maintenance project, its effects on the rights-of-way on public lands would be considered operation and maintenance of the existing authorizations and will not require any further analysis by the BLM. Thank you for your coordination and cooperation with the BLM since June 2008, to develop the Corridor Management Plan.

This authorizes Arizona Public Service (APS) to proceed with operation and maintenance vegetation management of the twin 500 kilovolt Navajo to Westwing Power Line rights-of-way. This power line includes 27 miles of public land rights-of-way, including the Agua Fria National Monument in the north to public lands three miles west of New River, Arizona to the south.

The BLM right-of-way AZA-6121 was granted on April 17, 1972. The right-of-way authorization on State Land (AZA-27240), which was subsequently acquired by the BLM (declarations of takings dated June 27, 1990, and April 19, 1991), was granted on October 20, 1976. The Agua Fria National Monument was designated January 11, 2000. Valid existing rights including the rights-of-way were acknowledged and validated in the Monument proclamation.

As we have discussed multiple times, some of the public lands in the project area contain remarkable cultural and natural resources. The APS-sponsored archaeological survey will bear significant new information about cultural sites in the area, which will be valuable for generations to come. The Plan's protocol to protect all such sites from treatment work with heavy equipment is fundamental to a sustainable vegetation maintenance approach on the Monument and public lands.

Likewise, the precautions to reduce impacts to flora and fauna are critical elements of the plan. These precautions include identifying procedures for dealing with special status species and native plants. The BLM recognizes that as a utility, APS is exempt from the Arizona native plant law. Nevertheless, APS will contract out the salvage of saguaro cacti where possible and safe, and under the power line towers. In coordination with the BLM, salvaged saguaros will be made available for transplant to public entities including parks, schools, and municipalities.

Thank you for your close coordination in the development of the Corridor Management Plan.

You may contact me or Natural Resource Specialist Amanda James at 623-580-5500 with any questions.

Sincerely,

D. Remington Hawes

D. Remington Hawes
Agua Fria National Monument Manager
Acting Hassayampa Field Manager

Arizona Public Service
300 North Granite Street
Prescott, AZ 86301
Phone: 928-443-6784

Amendment to APS Power Line Corridor Management Plan for Vegetation Management
500-2 Navajo to Westwing Power Line
April 2, 2009

Bureau of Land Management

Prepared By:
Lisa Young
Natural Resource Specialist
Arizona Public Service

Overview

On March 25, 2009, Bureau of Land Management (BLM) staff and Arizona Public Service (APS) met to discuss the vegetation management of the 500-2 power lines as it had occurred to date, to discuss a change in saguaro protocol, and to discuss mitigation for a couple of locations within the project area. This amendment to the original Corridor Management Plan (CMP) dated October 2, 2008, is intended to document the changes in protocol and mitigation agreements.

Amendment to Saguaro Treatment Protocol

APS has revised the standard protocol for addressing saguaros within the transmission rights-of-way (ROW). This document will simply describe the new protocol for saguaro treatment and how this applies to the current and ongoing maintenance of the 500-2 Navajo to Westwing power line on BLM land. Some areas of the 500-2 line on BLM land have already been treated according to the old protocol as it is described in the October 2, 2008 CMP. Specifically the northern extent of saguaros along these lines in the Agua Fria National Monument to Black Canyon City east of I-17 was treated using the old protocol, though there are a few areas that were skipped due to lack of access for the mechanical mowers. All the areas skipped and the rest of the power line corridor to the south on BLM land will be treated using the amended saguaro protocol as described here:

1. All saguaro treatment will be conducted within the permitted ROW for these lines.
2. All cultural sites will be located and flagged with a 50 foot buffer prior to saguaro removal and relocation.
3. If a saguaro occurs in a cultural site, the saguaro will not be relocated or treated using mechanical mowers. Saguaros in cultural sites that are within 22 feet of the conductors at maximum load conditions will be cut using hand crews. Saguaros greater than 22 feet from the conductors at maximum load conditions that occur in cultural sites will be left on site.
4. Saguaros for which any portion of the plant comes within 22 feet of the power line conductors at their maximum load conditions will require removal using mechanical mowers or hand crews. Mechanical mowers will be used to mulch the saguaro in most cases, but hand crews may also be used. Only hand crews will be used if the saguaro is present within a cultural site.
5. Where possible, APS will relocate saguaros that meet all the following criteria:
    a. The saguaro is less than or equal to 10 feet in height
    b. The saguaro is within the wire zone of the lines or could potentially grow to become a hazard to the lines in the future
    c. The saguaro is greater than 22 feet from the power line conductors at their maximum load conditions
    d. The saguaro does not occur within an archeology site

e. Terrain, access, and other environmental or logistical factors are favorable to relocation of the saguaro.
f. The saguaro is in good health

6. Saguaros will remain on site that do not meet the conditions of #4 or #5; namely, saguaros that are greater than 10 feet tall, are greater than 22 feet from the power line conductors at their maximum load conditions, are determine unsuitable for relocation, and/or that occur within an archeology site. These saguaros could be potentially treated in the future if they grow within the 22 feet violation distance.
7. Saguaros to be relocated will be moved to an area absent of cultural resources outside of the wire zone and away from the low sag area for these lines.

Mitigation

Field visits and discussions with BLM indicated a few areas within the project area on the Agua Fria National Monument (AFNM) for which APS has agreed to mitigate damages. The following mitigation will be conducted by APS:

1. On the AFNM, an error occurred in marking saguaros for salvage and some saguaros that would have been salvaged were removed. In order to mitigate for this damage, APS and BLM will estimate the number of saguaros and the value of those saguaros using existing data and will coordinate to determine the most appropriate mitigation for this value.
2. The BLM identified a few areas on the AFNM where mechanical mowers caused some rutting during work operations. APS, in coordination with the BLM, will repair the rutting damage identified by the BLM.
3. The BLM identified a few areas for which they have requested APS to re-seed. APS will coordinate with the BLM to obtain the appropriate seed mix and to identify the areas for which re-seeding will occur.

Signatures

We have reviewed the amendment to the saguaro protocol and the mitigation procedures and agree to the protocols and conditions described in this document:

D. Rem Hawes Date 4/24/2009

Rem Hawes
Manager, Agua Fria National Monument
Bureau of Land Management

Lisa Young Date 4.29.2009

Lisa Young
Natural Resource Specialist
Arizona Public Service

Jeff Spohn Date 4-30-09

Jeff Spohn
Forestry Division Leader
Arizona Public Service

Arizona Public Service
300 North Granite Street
Prescott, AZ 86301
Phone: 928-443-6784

APS Power Line Corridor Management Plan for Vegetation Management
500-2 Navajo to Westwing Power Line
October 2, 2008

Bureau of Land Management

Prepared By:
Lisa Young
Biologist
Arizona Public Service

Table of Contents

INTRODUCTION

This Corridor Management Plan describes the procedures proposed by Arizona Public Service (APS) for the ongoing management of vegetation (utility vegetation management) along the 500-2 Navajo to Westwing 500kV transmission power line on Bureau of Land Management (BLM) Land. The vegetation management of this power line will include an initial corridor clearing (referred to henceforth as 'initial clearing'), ongoing hazard vegetation pruning or removal, and follow-up routine vegetation maintenance scheduled cyclically approximately every five years. This corridor management plan describes the proposed actions for these maintenance activities and the clearance standards for the maintenance of this power line.

Vegetation maintenance serves four main purposes: 1) provides reliable, uninterrupted service to customers; 2) provides safe and efficient transmission of power along existing lines; 3) provides safe and reasonable access to the lines and structures for inspection and maintenance; and 4) provides protection against wildfires by reducing the potential for fire ignition from vegetation in around the power lines, and reduces fuel load under the lines which reduces effects of existing fires damaging structures or causing a power fault in the lines. Failure to address vegetation clearance and fuel hazards could result in wildfires, major power outages, and injury to life or property. Additionally, new federal energy regulations mandate vegetation inspections and treatment to maintain lines in safe and reliable operating conditions (NERC Reliability Standard FAC-003-1). These new federal regulations require mandatory compliance to reliability standards dealing with various aspects of the planning and operation of the power system, including vegetation maintenance. The North American Electric Reliability Corp. (NERC) monitors utility compliance with these standards and may impose fines, restrictions, or directives for corrective action to utilities not in compliance. Fines are $1,000 to $1 million a day if vegetation violates the mandatory standards. It goes without saying that APS will do all they can to avoid fines of this nature. Thus, because of the reasons listed here, APS proposes to maintain vegetation along their 500-2 power line.

OPERATIONAL PROCEDURES

GENERAL DESCRIPTION

The 500-2 power line is a 500 kV transmission line that begins at Navajo Generating Plant east of Page, AZ, heads south-west from there to just north-east of Ashfork, AZ where it bends and continues south to terminate at the Westwing Substation in Phoenix, AZ. This transmission line consists of two parallel, high-voltage transmission lines with the eastern line called the West Wing Line and the western line called the Moenkopi Line. These two lines are referred to collectively as the 500-2 power line. The total power line distance in Arizona for the 500-2 line is 256.9 miles and occurs across various land owners as shown in Table 1. Maintenance activities on other land ownership will be coordinated with that land owner and will not be addressed in this corridor management

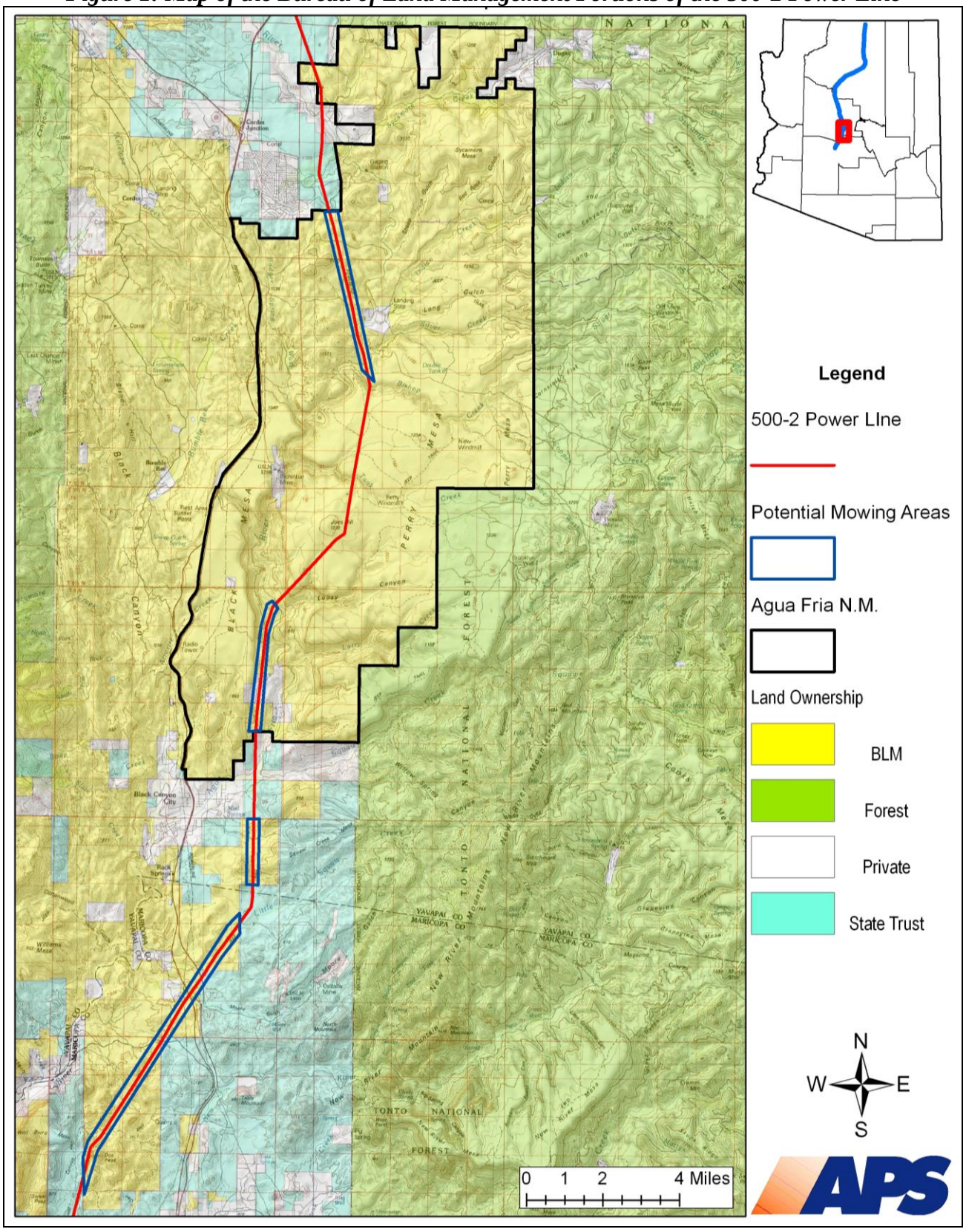
plan. The portions of line on BLM land is 27 miles long. The majority of the BLM land the line crosses is on the Agua Fria National Monument.

Table 1: Land Ownership for the 345-1 Power Line

Land Ownership	**Distance in Miles**
Bureau of Land Management	27.0
Bureau of Reclamation	0.7
Kaibab National Forest	27.0
Navajo Indian Reservation	96.1
Prescott National Forest	37.9
Private Land	21.4
State Trust Land	46.7
Total Miles	**256.9**

The proposed vegetation management is in compliance with the BLM authorization for this line. There are two authorizations for the 500-2 transmission line on BLM. Authorization #A-6121 has a Right-of-Way (ROW) width of 330 feet wide, was granted on February 17, 1972 and expires on April 17, 2022. Authorization #A-27240 was originally a State Land permit but the ownership was transferred to BLM. This authorization also has a ROW width of 330 feet, and was granted on October 20, 1976, and expires on October 19, 2026. The total acres of power line ROW on BLM land is 1,080 total acres (330 ft. ROW x 27 miles long x 5280 feet per mile/ 43,560).

Figure 1: Map of the Bureau of Land Management Portions of the 500-2 Power Line



PATROLS

APS conducts patrols regularly to inspect the condition of the vegetation within the corridor, identify hazards, plan vegetation management for the line, and inspect the corridor response to previous vegetation treatments. These patrols may be conducted on the ground and through helicopter flights.

Aerial Patrols

APS currently contracts a passenger helicopter for the aerial patrols along the power lines. For the 500-2 line, aerial patrols occur approximately four times a year spaced out throughout the year.

When the helicopter surveys a power line, the helicopter generally flies from about 50 to 300 feet off the ground at 70 to 95 miles per hour above or to the side of the power line. Flights occur during the day anytime between 6:00 a.m. and 5:30 p.m. from Monday to Friday. During helicopter flights, the helicopter may hover or circle over possible hazard vegetation locations. The helicopter also occasionally lands in open areas near the power line to get a closer look at vegetation or for a rest.

Ground Patrols

Ground patrols may occur at any time of year. This power line may be ground patrolled one to two times a year, often only in specific locations to follow up with vegetation identified in the aerial patrol. Ground patrols would also occur prior to a routine vegetation maintenance project to plan the work (about once every five years). This patrol would occur throughout most of the power line corridor, rather than just in areas where aerial patrols identified vegetation of concern.

During the ground patrol, the work planner gathers information on vegetation type, terrain, method of treatment (hand crew or mowers), and any additional information that would be beneficial for planning the work. Generally, one to two people are involved in conducting the ground patrols by driving a pickup truck, ATV (quad or 6-wheeler), or by walking. The ground surveys occur during the day anytime between 6:00 a.m. to 5:30 p.m. from Monday to Friday.

VEGETATION CLEARING STANDARD

APS proposes to clear vegetation throughout the 330 foot wide 500-2 power line ROW on BLM land. This would include removing all woody vegetation throughout the corridor under and between the power line wires and within a 40 foot radial distance around the footers of each tower and underneath the tower, and the removal of tall growing vegetation and some low growing vegetation outside the wires out to the permitted ROW edge. This vegetation clearing could potentially impact 1,080 acres on BLM land, but this is likely overestimate because not all areas would require treatment due to vegetation type and terrain. APS would clear all tall growing vegetation under the power line wires

within 50 feet below and to either side of the conductors at the time of lowest sag (lowest sag occurs in the summer when the load on the lines is high). In other words, areas where the lines occur over slopes, drainages, and small canyons, vegetation within 50 feet below the power lines would be treated. In addition, in areas where the lines are over slopes, drainages, canyons, and washes, tall growing woody vegetation would be thinned to reduce fuel load under the line.

TREATMENT METHODS

The vegetation maintenance of the 500-2 power line corridor will include three types of treatment methods which are summarized below. Treatment methods for these are described in detail below. All work is conducted Monday through Friday during daytime hours. When scheduling the timing of work activities, APS will coordinate with the AZ Game and Fish Department to determine hunting seasons within game management unit 21 on the Agua Fria National Monument. APS will be considerate of the hunting season and will schedule work during the most appropriate time to reduce interaction with hunters and avoid negative impacts during the hunting seasons as much as possible. APS will also place signs along the roads near areas of operation to notify the public of the work in progress.

1. **Initial Vegetation Clearing:** The initial clearing of the power line will involve removing woody vegetation within the 330 foot power line ROW. Initial clearing is anticipated to begin in the fall of 2008 and take about 2 to 4 months to complete, if work is uninterrupted. The initial clearing would include mechanical and manual methods of vegetation treatment. Manual methods could involve from 40 to 80 line clearance tree workers spread out along the power lines. This type of clearing has not been done on this line for a long time, and this initial clearing will be conducted to bring the corridor up to vegetation clearance standards.

2. **Routine Vegetation Maintenance:** Following the initial clearing of the 500-2 power line, the corridor will require continual maintenance to address any new growth of limbs or woody vegetation that encroaches within the corridor. This routine maintenance will not widen the corridor beyond the permitted ROW and would be conducted using the same methods as the initial clearing. For the 500-2 line, this ongoing maintenance will be scheduled every 5 years following the initial clearing.

3. **Hazard Vegetation Removal and Pruning:** Vegetation posing a hazard (see hazard vegetation definition Appendix 1) to the power line or structures may be removed on an ongoing basis at any time. Hazard vegetation may also be addressed during the initial clearing and routine maintenance cycle. Hazard vegetation is removed or pruned as soon as possible after identification. Hazard vegetation is treated using 1 to 2 hand crews with 2 to 3 tree workers per crew.

Access Routes

APS would travel to and from the power line ROW using existing established roads and within the power line ROW. If established roads are not available for a particular area, work would be conducted by hand crews for that area and the crews would hike in from the nearest access point. Should a previously closed road be required for temporary access, APS would coordinate with the BLM to determine if temporarily opening the road would be possible.

Mechanical Vegetation Removal

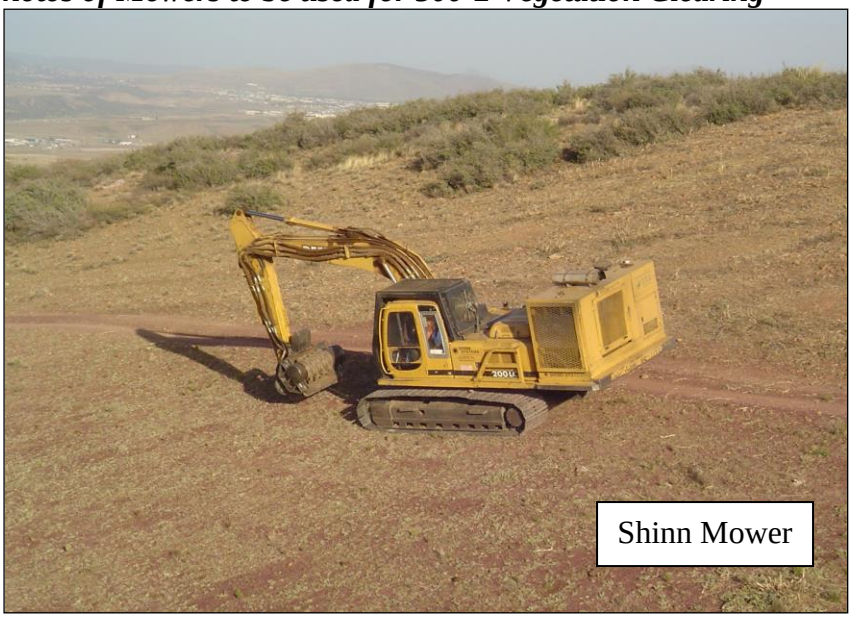
APS plans to use mechanical (mowing) methods for all areas within the 500-2 power line ROW for which access, terrain, or the lack of resource concerns allow and where mower use would be cost effective (i.e. it may not be cost effective to use mechanical methods in areas with sparse vegetation). Figure 1 above demonstrates the areas on BLM land that have been identified where mowing may be used as identified by access and terrain considerations. However, in some of these areas, the mower method may not be used if it is determined that this method would not be cost effective. Additionally, the mower would not be used within a 50 foot buffer around all cultural sites or within any additional areas identified with a resource concern. Mowing would also not be used across the Mesa between Bishop Creek and Lousy Canyon near Joe's Hill. Manual methods will be used in all areas where the mower method is not used.

Mechanical methods of vegetation removal within this ROW corridor will involve the use of two types of mowers that cuts and masticates vegetation. See Figure 2 below for photos of the mowers to be used for this line. The Hydro Ax mower is designed for mulching brush. It has an 8 foot long oscillating drum that works in 2 dimensions and is mounted on a rubber tired vehicle that can operate on moderate slopes. This mower cuts vegetation to ground level. The Shinn mower is designed to isolate and mulch a single tree and is typically used in areas with taller vegetation. This mower has a 3 foot oscillating drum mounted on a tracked vehicle that can operate on steeper slopes. This mower will cut and mulch the target tree to ground level.

The mower method of clearing vegetation is quick and cost effective in many areas and mulches the vegetation into small chipped pieces. Mowers typically are not able to operate at slopes of greater than 30%, so areas with slopes greater than 30% will be treated by hand crews.

The mower is operated by one driver and one grounds-person. The grounds-person directs the mower and may operate a chainsaw to cut trees that the mower is unable to access. Hand crews may also follow after the mower to clean up, scatter debris, and prune or remove trees that the mower could not access. All vegetation is mulched by the mower and left on site in the corridor piled no higher than four inches.

Figure 2: Photos of Mowers to be used for 500-2 Vegetation Clearing



Manual Vegetation Removal

In areas where the mower can not access the power line or where there are cultural or resource concerns, manual hand crews will be used to remove and prune vegetation within the power line ROW. Hand crews may also be used in areas where mechanical methods are used to clear around towers or in other areas where the mower can not access, or to aid in spreading mulched vegetation throughout the ROW. Hand crews would also be used for hazard vegetation treatments. The hand crews are trained in utility tree work and would use hand tools (chain saws, hand saws, rope) to cut branches

and trunks of vegetation and then lop and scatter the limbs and logs within the ROW as described below under "Vegetation Disposal".

Vegetation Disposal

Vegetation maintenance involves two vegetation disposal treatments. Stumps from tree removal are cut within 6 to 12 inches of the ground or if possible stumps are cut flush with the ground and no limbs and logs are placed within 25 feet of the high mark of streams or other bodies of water and all areas with the potential for flowing water (culverts, ditches, washes, etc.) are kept free of limbs, logs, and debris from vegetation removal operations. The treatments and conditions where they apply appear below:

1. Lop and Scatter: This method will be used in areas where manual treatments are used.
   - Limbs are lopped and scattered throughout the immediate area in a manner such that debris lies within 18-24" of the ground.
   - The logs are cut to manageable lengths of eight feet or less and left on site off of access routes
   - In areas of dense juniper, APS may pile logs off of the ROW for use as firewood.

2. Vegetation mulched: This method will be used in areas where mechanical treatments are used.
   - Limbs, and logs, and vegetation, are masticated by the mower and spread across the ROW no deeper than 4 inches deep.
   - Any vegetation that the mower can not treat would be treated using manual methods and disposed of as discussed in number 1 above.

Other Treatment Methods

Wild and Scenic Rivers:

The 500-2 lines cross over two areas with Wild and Scenic River characteristics. It has been determined that the lines are high enough above the floodplain and riparian vegetation that work in these two areas is not required. If vegetation treatments are needed on the canyon slopes of the Wild and Scenic River areas, the work will be conducted by hand crews and not by mechanical means.

Agave:

A State listed and BLM sensitive agave, Murphy's agave *(Agave murpheyi)* may occur within the 500-2 power line ROW on BLM. Additionally, other agave species are associated with cultural sites on the Agua Fria National Monument and may also occur within the 500-2 ROW. APS has agreed to avoid removing agaves wherever possible during implementation of the vegetation maintenance project. However, APS will remove agave plant species that have flowering stalks that reach 10 feet tall or taller in

the area underneath the lowest sage point of the wires (Murphy's agave stalks reach up to about 14 feet tall). Topography and the height of the power line wires at low sag will also be considered in determining where agaves may be left or where they would be removed.

Saguaro Transplanting:

Saguaros require removal as part of the vegetation maintenance along this power line. Saguaros around power lines pose a safety threat to the public as they are very conductive to electricity due to their height and high water density. Saguaros that approach close to the power line conductors can electrocute someone coming into contact with that saguaro or arc to the power line conductors tripping the line. These circumstances pose a safety hazard and thus saguaro treatment under the power line conductors is necessary.

APS in coordination with the BLM has agreed to transplant saguaros requiring removal where possible and reasonable. In order to determine a distance from the power line conductors for which it is safe to salvage a saguaro, we consulted with the APS safety department and Native Resources who is contracted for the salvage work, and reviewed industry standards for safe approach distance to energized wires. From this information and through conversations with BLM staff, APS will treat saguaro using the following methods:

1. Tall saguaros underneath the power lines and to 50 feet outside the outermost wires require removal, except in areas where vegetation is far below the power lines (50 feet below or greater) due to a canyon or slope.
2. Saguaros within approximately 100 foot radial distance from the footers of the power line towers may be salvaged. It was determined that this area, under many circumstances, is safe for salvage. Saguaros outside of the 100 foot radial distance may be unsafe to salvage and would require direct removal of the plant through hand crew cutting or mulching with a mower.
3. Saguaros within 31 feet of one of the conductors will not be salvaged because it was determined that saguaros at this distance are unsafe to salvage due to the electrical field and arcing potential of the wires, conductivity of salvaging equipment, and the distance needed to operate the equipment safely.
4. APS staff and Native Resources will determine which saguaros may be salvageable. These will then be reviewed by BLM. Factors such as terrain, access, health of the saguaro, and the number of arms on a saguaro, will determine whether a saguaro may be salvaged within the 100 foot distance around the power line towers. Salvage potential of a saguaro will be determined on an individual plant basis.
5. Native Resource staff, through coordination with APS, will flag all saguaros to salvage prior to initiating the saguaro salvage and removal portion of the vegetation work. The BLM staff will be given the opportunity to review the flagged saguaros and provide comment.
6. Salvaged saguaros will be moved to a holding site designated by the BLM. The saguaros will then be donated to non profit agencies or municipalities.

7. Native Resources will obtain a Removal and Transportation Permit from the Department of Agriculture for the saguaro salvage operation.

Following Vegetation Treatment:

As APS conducts the vegetation management along the 500-2 line, APS has agreed to document through photos to provide to the BLM the following work:

1. Document that work if required along Wild and Scenic River areas was conducted using hand crews
2. Document transplanting operation of saguaros

Native Plants

For the vegetation maintenance of the 500-2 power line, APS will need to remove native plants as part of the maintenance. Under the Arizona Revised Statutes of the Arizona Native Plant Law, Chapter 7, Article 1:3-915A, electrical transmission and distribution facilities are exempt from all laws and regulations under the Native Plant Law. Therefore, the removal or destruction of native plants within the 500-2 power line right-of-way will not require APS to obtain a permit from the Arizona Department of Agriculture, the agency that enforces the Native Plant Law. In the case of native plant transplanting, APS would not be required to obtain a permit. However, the salvager transporting the native plants is required to obtain a permit for removal and transportation.

SPECIALIST REPORTS

BIOLOGY

The project area and the proposed actions were assessed and it was determined that the vegetation maintenance of the 500-2 power line would have no effect on any federally listed, proposed, or candidate species or their critical habitats. This conclusion was based on one or more of the following for each of the species: 1) either the habitat for the species does not occur within the action area of this project; 2) project activities would occur far enough away from occupied or suitable habitat that it is expected that the project would have no affect on the species or its habitat; or 3) the species does not occur in the action area. Consequently, no conservation measures are necessary for minimizing effects to federally listed threatened or endangered species for this project. Sonoran Desert tortoise suitable habitat does occur within the project area. APS will follow the state guidelines for handling tortoise if a desert tortoise is encountered ("Guidelines for Handling Sonoran desert Tortoises Encountered on Development Projects", Arizona Game and Fish Department. Revised October 23, 2007. http://www.azgfd.gov/hgis/pdfs/Tortoisehandlingguidelines.pdf).

CULTURAL

The entire 500-2 corridor has been surveyed for cultural resources by Logan Simpson Design. A report is currently in preparation and will be submitted to the BLM for review and comment upon completion.

I. Management Goal for Cultural Resources

The management goal for cultural resources is to avoid adverse effects to historic properties that are on, or may be eligible for the State or National Registers of Historic Places within the Area of Potential Effect (APE) for all APS maintenance activities.

II. Operational Procedures

APS commits to avoiding adverse effects to historic properties that are on, or may be eligible for, the National Register of Historic Places. This will be accomplished through the following:

1. APS shall ensure through consultation between its archaeologist and the appropriate BLM Archaeologist(s) that a current and adequate Class III cultural resources survey inventory exists for all proposed projects which may be considered undertakings under Section 106 of the National Historic Preservation Act (NHPA).

2. If no current or adequate survey exists, APS shall either task its own archaeologist or will hire a qualified archaeological consultant to survey the APE, identify any historic properties within the APE, and prepare a report of the results to be submitted to the BLM Archaeologist for review and comment prior to the commencement of any proposed project on BLM lands.

3. The BLM Archaeologist shall review the report(s) for adequacy. Once an adequate report is received, BLM shall utilize the report to fulfill their obligations under Federal law regarding the treatment of historic properties. Once consultation is completed, BLM shall issue a clearance email or letter spelling out any terms of clearance and/or necessary mitigation measures for the project.

4. The agency may, through prior written agreement with APS, allow APS to proceed with vegetation management projects prior to issuance of a final clearance memo/letter, provided that the APE has been surveyed, all historic properties (either eligible for the National Register of Historic Places or those whose eligibility has not been determined) have been flagged for avoidance, and the sites are avoided by mechanized equipment. Only hand-cutting of vegetation will be allowed within site boundaries. APS and BLM shall work out the specific terms of such an agreement in advance.

5. Should APS be allowed to perform vegetation management prior to the issuance of final documentation (clearance memo/letter) APS shall ensure that all reports and other documentation are submitted to the BLM within a timely fashion.

6. APS through its archaeologist shall regularly communicate with the BLM Archaeologist regarding its activities as they involve historic properties. Should any activities inadvertently affect a historic property, or should previously unidentified historic properties be discovered during the course of APS maintenance activities, all work in that specific location shall cease and the APS archaeologist shall immediately notify the BLM archaeologist to arrange for the appropriate treatment and disposition of that resource.

7. Any disputes or problems that may arise shall be resolved through discussions between the BLM archaeologist and the APS archaeologist, with additional guidance from the Arizona State Historic Preservation Office or other mutually agreed upon parties as necessary.

CONSERVATION MEASURES

APS has agreed to implement the following mitigation/conservation in implementing the vegetation management along the 500-2 power line.

1. For mowing projects, all historic properties shall be flagged for avoidance utilizing a 50' buffer. Mowing crews will be briefed by the APS archaeologist prior to the commencement of fieldwork to ensure sites are not affected. Any vegetation maintenance that needs to be done within site boundaries will only be done using hand cutting crews. If a site has been identified as having a contributing element that might be affected by hand-cutting, such as a tree, or a structure that might be impacted by a falling tree, APS shall insure that hand-cutting within these sites shall be done in consultation with the appropriate BLM Archaeologist and that cutting on these sites will be monitored by an archaeologist.

2. APS will use hand crews and not mowing methods to treat vegetation on the mesa between Bishop Creek and Lousy Canyon near Joe's Hill.

3. During project implementation, APS will place signs along the roads near areas of operation to notify the public of the work in progress.

4. APS will use the following mitigation procedure during times of fire restriction:
    a. Contractors and APS tree workers will have one fire tool per person at the vegetation treatment site.
    b. Each truck will have one Indian Water Pump on site.
    c. Mowers will have 500 gallon Water Tenders on site

d. APS leadership personnel are red carded.

5. APS will salvage saguaros where possible and reasonable according to the salvage prescription as described above.

6. APS will avoid impacts to agave plants where possible. However, APS will remove agave plant species that have flowering stalks that reach 10 feet tall or taller in the area underneath the lowest sage point of the wires. Topography and the height of the power line wires at low sag will also be considered in determining where agaves may be left or where they would be removed.

7. If maintenance is required in areas of Wild and Scenic Rivers, APS will treat vegetation using hand crews and not by mechanical methods.

8. In areas with Sonoran desert tortoise suitable habitat, APS will follow the state guidelines for handling tortoise if a desert tortoise is encountered ("Guidelines for Handling Sonoran desert Tortoises Encountered on Development Projects", Arizona Game and Fish Department. Revised October 23, 2007. http://www.azgfd.gov/hgis/pdfs/Tortoisehandlingguidelines.pdf).

9. When scheduling the timing of work activities, APS will coordinate with the AZ Game and Fish Department to determine hunting seasons within game management unit 21 on the Agua Fria National Monument. APS will be considerate of the hunting season and will schedule work during the most appropriate time to reduce interaction with hunters and avoid negative impacts during the hunting seasons as much as possible.

SIGNATURES

We agree to the proposed actions and conditions contained within this Corridor Management Plan for the vegetation maintenance along the 500-2 power line on Bureau of Land Management land:

_____ Date _____
Lisa Young
APS

_____ Date _____
Jeff Spohn
APS

_____ Date _____
Rem Hawes
BLM

500-2 APS Power Line Corridor Management Plan 10/2/2008
Bureau of Land Management

SIGNATURES

We agree to the proposed actions and conditions contained within this Corridor Management Plan for the vegetation maintenance along the 500-2 power line on Bureau of Land Management land:

Lisa Young
APS
Date 10-2-08

Jeff Spahn
APS
Date 10-2-08

Rem Hawes
BLM
Date 10/14/08

APPENDIX 1: DEFINITIONS

Arc: The flow of electricity across a gap (through the air) from one conductor to another or to a grounded object. Arcing potential is evaluated by using accepted industry standards such as the National Electric Safety Code.

Conductor: A wire, combination of wires, bus bar, rod or tube suitable for carrying an electrical current. When describing a power line, may often be interchangeably referred to as a power line, line, phase, circuit, wire, cable, or primary. Any material that allows electricity to be carried through it.

Energized: Synonymous to "live" or "hot".

Energized Conductor: An electrically energized wire or other object that is conducting electricity.

Flashover: An unintended electrical discharge to ground or another phase. Flashovers can occur between two conductors, across insulators to ground or equipment bushings to ground. Caused by placing a voltage across the air space that results in the ionization of the air space.

Hazard Vegetation: Hazard vegetation is a live or dead standing tree or vegetation having defects, singly or combined, in the roots, butt, bole, or limbs, which predispose it to imminent mechanical failure to the whole or part of a utility line, pole, or tower. The tree or vegetation must be located such that a failure of the tree or vegetation (or any part of the tree or vegetation) has a probability of causing damage to the utility line, pole, or tower. A "defect" is an injury or disease that seriously weakens the stems, roots, or branches of the tree or vegetation, predisposing it to fail (e.g., broken branches, split top) to continue standing. "Imminent" implies that damage resulting to the utility line, pole, or tower from the tree or vegetation could occur at any time. This definition applies to any vegetation that poses an immediate threat to a utility line. Hazard vegetation can include vegetation with arc potential (see Arc definition). Trees or vegetation (including saguaro cactus) with arc potential may be healthy with no defects predisposing them to imminent mechanical failure, but if vegetation is within arcing potential from a transmission or distribution line, it may pose a hazard. In order to eliminate hazards, pruning or removal of the hazard would be necessary.

Integrated Vegetation Management (IVM): A system of managing plant communities in which compatible and incompatible vegetation is identified, action thresholds are considered, control methods are evaluated, and selective controls are implemented to achieve a specific objective. Choice of control methods is based on effectiveness, environmental impact, site characteristics, safety, security, and economics.

Kilovolt (kV): 1,000 volts.

Routine Vegetation Maintenance: The process of identifying and removing or pruning vegetation within the power line corridor for the purpose of providing safe, efficient, and reliable delivery of electricity. Proper clearance must be maintained at all times between power lines, trees, the ground, buildings, etc., taking into consideration a reasonable re-entry time between clearance cycles.

Span: The horizontal distance between two adjacent power poles.

Transmission Power Line: Heavy wires that carry large amounts of electricity at very high voltages over long distances from a generating station to a substation. Transmission voltages range from 69,000 to 500,000 volts (69 – 500kV).

Utility Vegetation Management: The process of managing vegetation surrounding utility lines for the purpose of providing safe, efficient and reliable delivery of electricity while minimizing vegetation related fires. Vegetation management includes routine vegetation maintenance, removing and pruning hazard vegetation, vegetation control around poles, structures, and other electric facilities. Vegetation management involves manual and mechanical treatment of vegetation, pre- and post inspections of vegetation, and disposal of vegetation.

Arizona Public Service
300 North Granite Street
Prescott, AZ 86301
Phone: 928-776-3663

APS Transmission Line Corridor Management Plan for Vegetation Management
500-2 Navajo-Westwing Transmission line

February 26, 2014

Prescott National Forest

Prepared By
Joshua Schwartz
Arizona Public Service
In collaboration with the Prescott National Forest

Table of Contents

CMP CHANGE TRACKING TABLE

Any minor or major revisions to the CMP and appendices following initial authorization and signature must be tracked in this table. For each version, change the version number on the title page. For APS Forestry, only Natural Resource Specialist, Forestry Leader, or Department Manager is authorized to approve changes. For PNF, only District Ranger or Forest Supervisor is authorized to approve. Any major or significant revisions must be approved by APS and Forest Supervisor at the discretion of each party. For each change, the last signer must input the date signed in the Effective Date column.

Version	Effective Date	Description	Revised By	Approved By			
					Date	Signature	Name
				APS			
				PNF			
				APS			
				PNF			
				APS			
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INTRODUCTION

This Transmission Line Corridor Management Plan (CMP) describes the procedures proposed by Arizona Public Service (APS) for the management of vegetation (utility vegetation management) along the 500-2 transmission line on the Prescott National Forest (PNF). Once approved, the CMP is in place for the life of the permit or until a significant change to vegetation management practices, a change to APS or PNF policy, or other significant event triggers the need for a new CMP or major revisions. This CMP may be cancelled at any time according to the discretion of either PNF and/or APS. This CMP is to be reviewed prior to each cycle of routine vegetation maintenance by APS and PNF.

The vegetation management of this power line will involve routine vegetation maintenance and hazard vegetation treatments, and follow-up routine vegetation maintenance scheduled cyclically approximately every five years. This operating plan describes the proposed actions for these maintenance activities on PNF, the conservation measures that will be implemented for these activities, the clearance standards for the maintenance of this power line, and the specialist reports that have been conducted for the line.

Industry standards, regulations, and recommendations governing maintenance include: ANSI A300 Part 1-1001; A300 Part 7-2006; ANSI Z133; ANSI 2006; OSHA (29 CFR 1910.269); NESC 2007; RUS (USDA 7 CFR Part 1738); FERC; and the Arizona Corporation Commission.

This operating plan was developed in accordance with the Guidelines for Vegetation Management in Utility Corridors in Arizona (UVM Guidelines), and USFWS Biological Opinion # AESO/SE 22410-2007-F-0365.

CMP MANAGEMENT

PROJECT SPECIFIC TREATMENT PROCESS

For each individual cycle of work, specific treatments may be needed for only that cycle, but may not apply for future cycles. Prior to each cycle of work, this CMP will be reviewed to determine if any Project Specific Treatments will be needed. All project specific treatments will be determined in coordination between APS and a PNF representative and documented in Appendix 5: Project Specific Treatment Tracking. Project Specific Treatments will be approved by the appropriate representatives from APS and PNF.

These items will always be discussed for specific treatments prior to each cycle of work, though there may be other items that apply:

1. Specific slash disposal or chipping at road or trail crossing
2. Vegetation buffers at road crossings
3. Access routes to the lines and specific measures to be followed at access routes where applicable

4. List sensitive areas other than what is already included in the CMP and what is required at that location.
   Sensitive areas may include:
   a. Species restrictions or stipulations other than what is covered in the Conservation Measures section
   b. Timing or access restrictions due to other circumstances (e.g. a certain area is closed for work during May because of high public use)
   c. Areas of visual concerns with specific requirements, including trails, roads, and scenic view sheds

WORK OVERSIGHT

In order to ensure that all items in this CMP are communicated, understood, and followed by the APS employees and contractors involved in vegetation maintenance of the 500-2 line, APS will ensure the following actions occur prior to implementation of vegetation maintenance work:

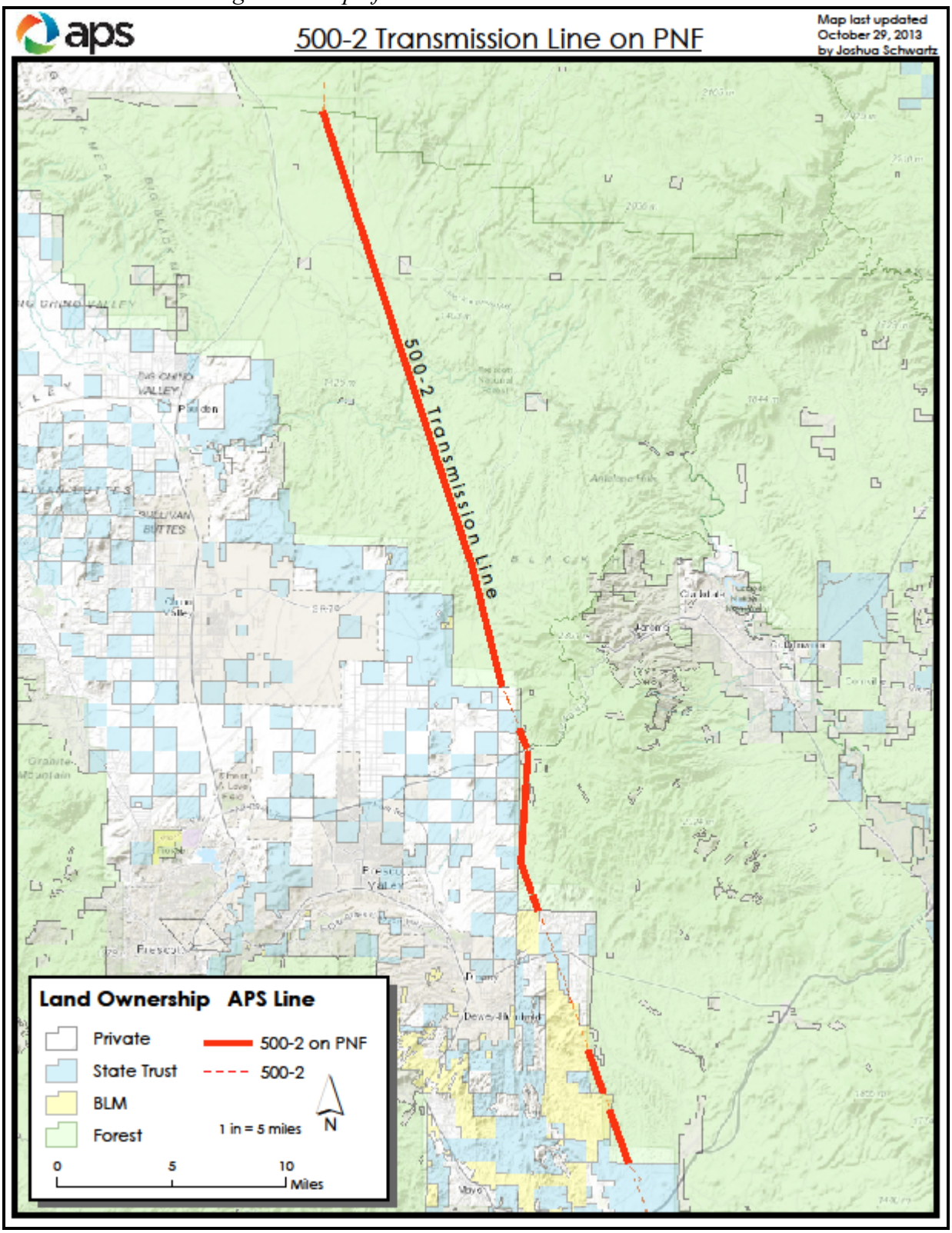
1. A map of the project, called the project map, will be provided to the crews prior to work showing all special treatment areas if applicable; these may include work type (mow or hand crew), conservation measure areas, areas where visual buffer is needed and any sensitive area that requires specific mitigation or change in standard protocol.
2. The APS Natural Resource Specialist assigned as liaison with the PNF will review all project specifications and requirements from this CMP and project map (if applicable) with the APS Forestry Leader, Planner, or Coordinator in charge of project implementation.
3. The Leader, Planner, or Coordinator will review all project specifications and requirements from this CMP and project map (if applicable) with the work crews and obtain sign-off that the crews understand the project requirements. The agency will be notified of the date of this meeting and may choose to attend.
4. The Leader, Planner, and/or Coordinator will make periodic site visits during work implementation to check on work and ensure work is conducted as agreed upon with PNF.
5. Upon completion of the work, the Leader, Planner or Coordinator will conduct an audit to verify that the work was completed correctly.

GENERAL DESCRIPTION

The 500-2 Navajo-Westwing transmission line begins at the Navajo generating station in Page, AZ and feeds into the Westwing substation in Phoenix, AZ. This double-circuit transmission line is 205[1] miles in length, with 38 miles occurring on PNF. **CHI401919 (P-41)** is the special use permit issued to APS by PNF for this transmission line. The permit is due to expire on **12/01/2022**. The Right-of-Way (ROW) for this line is **330** feet wide with a total of 1525 acres on PNF. Figure 1 shows the location of this transmission line on PNF.

[1] The 500-2 is a double circuit – this means there are 2 circuits that run in parallel. All calculations in this CMP have been made using the length of a single circuit. For example, the total length of both circuits on PNF is 76 miles. 76/2 = 38 miles. This same single-circuit method was employed for all area and length calculations in this CMP.

Figure 1: Map of the 500-2 transmission line on PNF



There are multiple vegetation types along the transmission line on PNF. Table 2 below lists each vegetation type and the length in miles of transmission line within that vegetation type.

Table 2: Vegetation Type along the APS Transmission Lines on PNF

Vegetation Type	Length in Miles
Colorado Plateau Grassland	3.34
Cottonwood Willow Riparian Forest	0.37
Interior Chaparral	4.81
Mixed Broadleaf Deciduous Riparian Forest	0.04
PJ-Chaparral	9.79
PJ-Grassland	11.31
PJ-Woodland (persistent)	3.70
Semi-Desert Grassland	4.63
Grand Total	37.99

OPERATIONAL PROCEDURES

APS proposes to maintain the vegetation along the transmission power line that could interfere with the lines or could become a fuel load issue along the line on PNF. The vegetation management process includes the clearing of vegetation within the ROW on a routine cyclical basis approximately every 5 years, as well as the occasional removal of hazard trees within or outside the ROW (sees Hazard Tree definition in Appendix 1 and the Hazard Vegetation section below for details). As the vegetation maintenance (also referred to as clearing) prescription is followed, the corridor should be converted to low growing plant communities that do not interfere with overhead power lines, pose a fire hazard, or hamper access.

VEGETATION CLEARING PRESCRIPTION

The overall vegetation clearing treatment prescription will include the following actions. The biological, cultural, and vegetation conservation measures and mitigations listed below under the Conservation Measures and Mitigations section also apply to vegetation clearing work.

1. APS will conduct vegetation clearing in 2014 following approval of this CMP and coordination with the PNF.
2. For future cycles of vegetation clearing, APS will contact the PNF liaison 1 month in advance to coordinate project details and any changes in policy and/or natural resources for each maintenance cycle on transmission lines. Any cycle specific maintenance agreements will be tracked in appendix 5.
3. Vegetation clearing work will occur cyclically approximately every 5 years.

4. APS will cut down all tall growing vegetation and some lower growing woody vegetation within the line ROW. Tall growing vegetation includes piñon pine (*Pinus edulis*), juniper (*Juniperus spp.*) and oaks (*Quercus spp.*)
    a. To reduce fuel around the structures all woody shrubs will be cut within a 40 foot radius around each pole.
5. No herbaceous or grass species will be treated within the ROW or around poles.
6. Where lines span canyons and drainages, and where line height is such that clearance standards can be maintained, no treatment will take place unless it is needed to break up heavy fuel loads.
7. Pruning or removal of hazard vegetation may occur outside of the ROW (see hazard vegetation section).
8. If possible, and as long as minimum clearance requirements are met, vegetation will be retained as a visual buffer in the ROW near homes, private land and scenic highways.
9. Vehicles will not be used on saturated soils resulting from precipitation, or in riparian areas.
10. The use of any tracked vehicles will be reported and pre-approved by PNF prior to use.
11. Vegetation treatment activities will be done using manual hand crew methods and by mechanical mowers.
12. APS will follow the Utility Vegetation Management guidelines dated 11/28/2006.
13. Riparian Treatment: riparian ecosystems are some of the most sensitive and important areas on Prescott National Forest and high value is placed on these areas by both the public and the Agency. Consequently, adherence to the agreed upon specifications is key in these areas. There are 2 locations where the 500-2 occurs on riparian areas:

    a. Yarber Wash (PLSS 12N2E11 and 12N2E14) – This is an intermittent wash. At this location the vegetation includes hackberry (*Celtis spp.*), mesquite (*Prosopis spp.*), catclaw (*Acacia gregii*), walnut (*juglans spp.*) and desert willow (*Salix spp.*). The line sags low at the wash crossings and treatment will be required here cyclically.

    b. Verde River crossing (PLSS 18N1E30 and 18N13E19) – The line passes high over the river and treatment should not be needed here. Any needed treatment will be coordinated in advance with the PNF.

MECHANICAL VEGETATION REMOVAL

Mechanical methods of vegetation removal within ROW corridors involve the use of a cutting device on an arm mounted on a tractor with tracks or rubber tires (called a mower) that cuts and masticates vegetation. The mower method of clearing vegetation is quick and cost effective in many areas and masticates the vegetation into small chipped pieces. Locations where mechanical mowing will be used will be determined prior to vegetation maintenance through coordination with each District to identify the best locations for mowing. Each mowing area will be identified on a map prior to work to be supplied to the PNF and to the maintenance crews. The prescription of treatment for each

mowing area will be agreed upon between APS and each District possibly with coordination during a field visit.

The mower is operated by one driver and one grounds-person. The grounds-person directs the mower and may operate a chainsaw to cut trees that the mower is unable to access. A hand crew may also follow after the mower to clean up, scatter debris, and prune or remove trees that the mower could not access. All vegetation is masticated by the mower and left on site in the corridor piled no higher than four inches. APS plans to use up to two mowers for the clearing of this line. They will also follow a public safety plan that outlines safety measures to use when the mower may come close to public roads or recreation areas. This will entail signage and watchmen whose sole duty will be traffic control in areas where operations may be a hazard to the public.

VEGETATION DISPOSAL

The following methods will be used for disposing vegetation for this project:

1. APS will contact the PNF contact prior to each cycle of maintenance for specific details required for vegetation disposal. Disposal specifics may include varied treatment due to fuel loading, trails requirements, cultural requirements, and biological requirements.
2. Stumps from vegetation treatments shall be cut within 6 inches of the ground, or if possible cut flush with the ground.
3. No slash or logs will be placed within 25 feet of the high mark of streams or other bodies of water.
4. All areas with the potential for flowing water (culverts, ditches, washes, etc.) shall be kept free of slash, logs, and debris from tree cutting and pruning operations.
5. In areas treated by hand crews, slash will be lopped and scattered throughout the immediate area in a manner such that debris lies within 18" of the ground.
6. Logs will be left to the greatest length as safely possible where felled, except where other requirements override this.
7. If practical and depending on the severity of infestation and FS recommendations, trees with evidence of current beetle infestation will be removed off site.
8. Vegetation masticated: This method will be used in areas where mechanical treatments are used, unless resource concerns dictate otherwise.
    a. Slash and logs are masticated by the mower and spread across the ROW no deeper than 4 inches deep.
    b. Any vegetation that the mower cannot treat would be treated using manual methods and disposed of as discussed in number 1 above.

ACCESS ROUTES

APS will use established roads and access routes to approach the line and will remain within the ROW for conducting work. APS will not create any new roads or access routes to enter the power line ROW, and will make every effort to minimize impact. Vehicles may include ATVs, pickup trucks, dump trucks, and chippers. If power lines are not accessible by road, APS will drive to the nearest location and crews will walk in with the necessary equipment.

FIRE PREVENTION

During the late spring and summer of each year, PNF often places restrictions on specific activities to help prevent the ignition of forest fires. Appendix 4 is the PNF Industrial Fire Precaution Plan and lists the different stages of fire restrictions. APS agrees to coordinate with PNF during fire restrictions. APS and their contractors are committed to preventing fires and will do the following things during times of fire risk:

1. Only use clear fueling areas to fuel equipment.
2. APS will submit daily crew locations to dispatch
3. Vehicles with hot exhausts will avoid parking in areas of flammable vegetation.
4. Chainsaws with hot exhausts will be placed on vehicles or on mineral soil.
5. Smoking is not permitted at the work site.
6. Crews will keep the following equipment with them at all times:
    a. 1 fire tool on site per person (examples: Pulaski, shovel)
    b. Indian Pump filled with water

HAZARD VEGETATION DESCRIPTION

Occasionally, vegetation that could pose a hazard to the line or structures may be identified. This section describes the process that APS and PNF have agreed to implement in the case of hazard vegetation.

APS has identified three levels of hazard vegetation, each of which will be dealt with in different ways:

Level 1: Emergency Hazard

An emergency hazard situation may occur when:

a. Vegetation is arcing to the line
b. A tree or limb has grown into contact with the line resulting in power faults or a fire hazard
c. A tree or limb has bent due to snow load, wind, or other weather condition such that the limb is arcing or is in contact with the line
d. A tree has been uprooted due to environmental conditions; and when all or a portion of a tree falls onto the line or structures. When an emergency hazard situation occurs, APS must act immediately to eliminate the hazard no matter the weather or road conditions or time of day or year. In these situations, the information listed under "Hazard Reporting" shall be gathered and reported to the PNF contacts **after** the hazard is eliminated along with a description of what occurred.

Level 2: Imminent Threat Hazard

There are two types of imminent threat hazards:

1. A live or dead standing tree or vegetation predisposed to imminent mechanical failure which could damage a utility line, pole, or tower.

2. A tree or branch that has come close enough to the power line such that it poses a safety risk to the public and/or tree workers.

Imminent threat hazards shall be treated as soon as possible. They are typically identified during Forestry annual line patrols, but may also be identified during a line maintenance patrol, aerial patrol, or reported by a customer or the public, or identified while any other type of work or patrol is conducted along the line. Once imminent threat hazards are identified, the information listed under "Hazard Reporting" is gathered and reported to the PNF contacts. PNF will have 2 business days to review the submittal.
If no response is received after 2 days, APS may proceed with the work. If reasonable and appropriate, and submitted within the review period, APS also agrees to implement any specific requirements identified by PNF (e.g. request regarding slash treatment). Because these trees pose an imminent threat, treatment may occur at any time and APS may be unable to follow specific timing restrictions associated with the area of work. During breeding seasons, per USFWS recommendations, APS will coordinate the timing of the hazard treatments so that work is consolidated into the least number of days of work and least number of trips in and out of sensitive species breeding areas in order to minimize the duration and frequency of disturbance.

Level 3: Off Cycle Hazards

This type of hazard includes any live or dead trees having defects that pose a future threat to the power line or structures and cannot be left untreated for the next growing season. These hazards do not pose an imminent threat but must be treated prior to the next growing season before they become an imminent threat. Treatment of Off Cycle trees may sometimes be scheduled around seasonal timing restrictions. Once an Off Cycle tree has been identified, APS will notify the PNF contacts with the information listed under "Hazard Reporting" and the timing and methods of treatment will be discussed between APS Forestry and PNF representatives.

Hazard Reporting

When APS identifies and treats any of the three levels of hazard vegetation, they will follow this process:

1. APS identifies the hazards and marks each for pruning or removal.

2. APS reports the hazard data to the appropriate PNF contact. The reporting and treatment timeframes for each level are:

    a. Level 1: Emergency Hazards: the reports are sent after the treatment is completed.

    b. Level 2: Imminent Threat Hazards: the reports are sent prior to work. PNF staff have 2 days to review and comment. If no comment is received by APS after the 2nd day, APS will proceed with treatment.

Level 3: Off Cycle Hazards: the reports are sent prior to work. APS coordinates with PNF staff to determine the most appropriate timing of treatment.

The following information is gathered for reporting to the PNF contacts:

1. The GPS location of the tree or vegetation.
2. The power line name and/or number.
3. It is noted whether the tree or vegetation is inside or outside of the ROW.
4. The status of the tree or vegetation (live or dead).
5. The species of the tree or vegetation.
6. Hazard vegetation is placed into one of the following size classes:
    a. 5 – 9" dbh
    b. 9 – 12" dbh
    c. 12 – 18" dbh
    d. 18 – 24" dbh
    e. 24" dbh or greater
7. The date the trees were marked.
8. The date of when the treatment action occurred.

TREATMENT METHODS

Certified line clearance tree workers will conduct all clearing and hazard work with hand tools (chain saws, hand saws, rope). Chippers may be used hauled by a dump truck or pickup truck. 2 to 30 tree workers may work on the line at one time.

SPECIALIST REPORTS

BIOLOGICAL ASSESSMENTS AND BIOLOGICAL OPINIONS

Biological consultation regarding impacts of vegetation maintenance on utility corridors to threatened and endangered species has been conducted for this line. The consultation was a programmatic process that assessed impacts to listed species on 5 National Forests in Arizona (Prescott, Coconino, Kaibab, Apache-Sitgreaves, and Tonto NFs). The Biological assessment is called "Phase II Maintenance in Utility Corridors on Arizona Forests" (referred to below as the Phase II Consultation) and was completed February 29, 2008 and submitted to FWS for their opinion. This consultation includes all utility maintenance related activities and assesses the effects of these activities on threatened, endangered, proposed, candidate species, and their critical habitat if designated. This consultation will be in effect for 10 years following completion of the Biological Opinion (BO). The BO was completed on July 17, 2008 (reference # AESO/SE 22410-2007-F-0365). The conservation measures and reporting requirements that resulted from this BO that apply to the vegetation management along the 500-2 line are listed below. All of these items will be followed in implementation of this project. On the 500-2 line no species specific conservation measures apply. Only general conservation measures apply.

HERITAGE RESOURCES

The management goal for heritage/cultural resources is to avoid adverse effects to historic properties that are on, or may be eligible for the State and/or National Registers of Historic Places within the Area of Potential Effect (APE) for all APS maintenance activities.

The entirety of the 500-2 ROW on PNF has been completely surveyed for heritage resources, and the results reported in:

"A Cultural Resources Survey of 6,104.79 Acres of State and Federal Lands for the Arizona Public Service Company 500-2 (Navajo–Westwing) 500-kV Transmission Line between the Westwing Substation and the Navajo Indian Reservation Boundary, Maricopa, Yavapai, and Coconino Counties, Arizona" by E. M. Laurila, D. A. Bild, M. S. Foster, J. S. Courtright, C. North, and E. Davis. LSD Technical Report No. 075107 (500-2c), Logan Simpson Design Inc., 2011.

A total of 46 archaeological sites were identified on the PNF. Prior to mowing the ROW, all National Register of Historic Places (NRHP)-eligible sites, or sites that have not been evaluated for NRHP eligibility, shall be flagged for avoidance by the mower(s) by a qualified archaeologist. Unevaluated sites shall be treated as eligible until such time as the PNF makes an eligibility determination on those sites. Linear in-use sites such as

roads or power lines shall not be marked, as due both the nature of the vegetation maintenance activities as well as the nature of the sites themselves, those sites will in no way be affected by the proposed maintenance activities. Flagging involves establishing a 50-foot buffer around each site and placing pink and white flagging marked with "APS" using a black Sharpie-type marker around each site so that each flag is visible from the next. Flagged sites will be hand cut using crews with chain saws and the slash lopped and scattered on-site. Sites deemed "fire sensitive" as defined in the USDA Region 3 FS Programmatic Agreement shall have all slash removed by hand carrying (no dragging of vegetation across sites) and the slash placed outside the flagged site boundaries but within the existing ROW. For this project those include site #s: AR-03-09-05-221 and 05-500. There will be no piling of slash at any time. A site table shall be provided to crews as a back-up in case flagging should disappear or be removed prior to the work being done. No mechanized mowing activities shall take place at any time within the boundaries of flagged sites. No vehicles shall enter flagged site boundaries except that they remain on existing roads. In order to avoid rutting, no work may take place during wet conditions as described elsewhere in this document.

APS through its archaeologist shall regularly communicate with the PNF Archaeologist regarding its activities as they involve heritage resources. Should any activities inadvertently affect any heritage resources, or should previously unidentified heritage resources be discovered during the course of APS maintenance activities, all work in that specific location shall cease and the APS archaeologist shall immediately notify the PNF archaeologist to arrange for the appropriate treatment and disposition of that resource. Any disputes or problems that may arise shall be resolved through discussions between the PNF archaeologist and the APS archaeologist, with additional guidance from the Arizona State Historic Preservation Office or other mutually agreed upon parties as necessary.

Should any previously unidentified heritage (cultural) resources (including burials and/or cremations) be discovered during any phase of this project, all work at that specific location will immediately cease, steps should be taken by the contractor and/or APS personnel to protect the discovery, and the APS Archaeologist (602-371-5298 W. or 602-677-1747 C.) should be contacted immediately in order to make arrangements for the proper treatment of the discovery in coordination with the PNF Forest Archaeologist.

CONSERVATION MEASURES

Yellow-billed Cuckoo and potential Critical Habitat:

1. Avoid ground work disturbance in the floodplain containing occupied breeding habitat between June 1 and August 30.
2. For APS LIDAR flights, APS will not land for refueling or stage the helicopter within 0.25 mile of yellow-billed cuckoo occupied habitat during the breeding season.
3. Riparian Treatment: riparian ecosystems are some of the most sensitive and important areas on Prescott National Forest and high value is placed on these

areas by both the public and the Agency. Riparian habitat along the Verde River has been identified as potential critical habitat for the yellow-billed cuckoo. Consequently, adherence to the agreed upon specifications is key in these areas.

a. Verde River crossing (PLSS 18N1E30 and 18N13E19) – The line passes high over the river and treatment should not be needed here. Any needed treatment in or near the riparian corridor will be coordinated in advance with biologists on the PNF in order to avoid or minimize adverse impacts to primary constituent elements.

General Noxious Weed Best Management Practices to minimize impact to T&E Species

1. Ensure that utility mower, track, or other off-road equipment, which has high potential to carry noxious weeds (not including service vehicles, pick-up trucks, or passenger cars) is free of soil, weeds, vegetative matter or other debris that could harbor seeds prior to entering national forests.
2. Utilities will consult with the appropriate FS contact to identify known or high probability noxious weed hotspots. In those areas, the utilities will ensure that mower, track, or other off-road equipment, that have high potential to carry noxious weeds (not including service vehicles, pick-up trucks, or passenger cars) are free of soil, weeds, vegetative matter or other debris that could harbor seeds prior to moving equipment between line segments.

Repair of Access Route Best Management Practices

1. When feasible, safe, and efficient to conduct maintenance work or inspections, walk into areas that are inaccessible under current route conditions.
2. If traffic control structures are present (boulders, barriers, dips) and must be moved, return structures and configuration to original position/design when work is complete.
3. Prune vegetation where feasible, and minimize the amount of vegetation trimmed along access route.
4. Minimize soil disturbance to reduce erosion.
5. Minimize rutting and repair per coordination with appropriate FS District.
6. Staging areas for loading and unloading of equipment should be located in previously disturbed areas, but outside of floodplains and other wet areas.

Reporting Requirements

APS must provide annually (Jan 30 of each year the biological opinion is in effect) to the FS and FWS, a summary of the activities conducted under the proposed action and Biological Assessment. The information will be used to assess if the actions as implemented were

accurately described and analyzed in the BA and BO, and that the effects of the action are not greater than anticipated.

Reporting of Hazard Vegetation Treatments:

The utilities shall provide a summary of hazard vegetation work activities as described in the proposed action for those species and/or critical habitat with "Likely to Adversely Affect" determinations. These species include the Mexican spotted owl (PACs and critical habitat), yellow-billed cuckoo (suitable and occupied habitat), and Southwestern willow flycatcher (occupied, suitable, and critical habitat). The summary shall include:

1. The GPS or geographic location of the tree(s) or vegetation.
2. The power line name and/or number.
3. The species and status of the tree (s) or vegetation (live or dead).
4. The size class of the tree (primarily applicable to MSO PACs and critical habitat).
5. The date the trees were located.
6. The number, size class, and species of trees that were damaged or removed due to felling the hazard tree or vegetation if applicable.
7. The date(s) of when the action occurred.
8. The wildlife or fish species and or their critical habitat in the vicinity of the action (i.e., MSO, cuckoo, flycatcher).

Reporting of Routine Vegetation Maintenance:

The utilities shall provide a summary of routine vegetation maintenance activities as described in the proposed action. The summary shall include:

1. The power line name and/or number.
2. A brief description of the activities conducted.
3. A start and end point of the area treated.
4. The dates of when the work was conducted.

Field Inspection of Treatment Activities

The Forest Service and Fish and Wildlife Service will annually schedule with the utilities, a patrol of selected sections of lines that were worked on during the previous year. Preferably, one terrestrial and one fisheries biologist from the FS and FWS that were on the Biological Assessment consultation team will attend the patrol. The purpose of the patrol will be to visually assess that the work conducted was in accordance with the description of the proposed action, and that the analysis of effects to the species was assessed appropriately in the BA.

Species Updates and Incorporation of New Information

The utilities will work with the FS, FWS, and Arizona Game and Fish Department (Heritage Data Management System), to annually update species information to ensure that new information is incorporated and assessed relative to the proposed action.

CONTACTS

The following is a list of contacts involved for vegetation management of distribution lines on PNF. The names included are those present for 2014. Future contacts may vary, though the job position for the contact should remain the same. All coordination for vegetation maintenance projects should be done through the PNF Liaison and APS Liaison. Coordination between specialists (e.g. biologist, forester, or archaeologist) should be conducted so that the liaisons remain informed on any discussion or agreement made.

APS CONTACTS

Joshua Schwartz
APS Liaison
Natural Resource Specialist
480-489-6233

Jon Shumaker
Natural Resource Specialist/Archeologist
602-371-5298

Tracy Moore
NW Forestry Division Leader
928-776-3663

Ramon Ortega
NW Forestry Division Coordinator
928-443-9714

PNF CONTACTS

Sheila Sandusky
PNF Liaison
928-567-1120; 928-499-2039 (c)

Ken Simeral
Lands Team Leader
928-443-8010; 928-830-8135 (c)

SIGNATURES

Prepared by: _____ **Date:** 12.3.13
Joshua Schwartz
Natural Resource Specialist
Arizona Public Service

Approved by: Tracy Moore **Date:** 11-22-13
Tracy Moore
NW Forestry Division Leader
Arizona Public Service

Responsible Parties

Approved by: _____ **Date:** 3-13-2014
Teresa Chase
Forest Supervisor
Prescott National Forest

APPENDIX 1: DEFINITIONS

36 CFR 800: The Federal Advisory Council on Historic Preservation's regulations describing the process for implementing Section 106 of the National Historic Preservation Act, as revised.

ARPA: The Archaeological Resources Protection Act of 1979, as amended.

Arc: The flow of electricity across a gap (through the air) from one conductor to another or to a grounded object. Arcing potential is evaluated by using accepted industry standards such as the National Electric Safety Code.

Conductor: A wire, combination of wires, bus bar, rod or tube suitable for carrying an electrical current. When describing a power line, may often be interchangeably referred to as a power line, line, phase, circuit, wire, cable, or primary. Any material that allows electricity to be carried through it.

Cultural Resource: Definitions vary, but essentially any resource that is of a cultural character. Cultural resources encompass archaeological, traditional, and built environment resources including but not limited to buildings, structures, objects, districts, and sites.

Energized: Synonymous to "live" or "hot".

Energized Conductor: An electrically energized wire or other object that is conducting electricity.

Flashover: An unintended electrical discharge to ground or another phase. Flashovers can occur between two conductors, across insulators to ground or equipment bushings to ground. Caused by placing a voltage across the air space that results in the ionization of the air space.

Hazard Vegetation: Hazard vegetation is a live or dead standing tree or vegetation having defects, singly or combined, in the roots, butt, bole, or limbs, which predispose it to imminent mechanical failure to the whole or part of a utility line, pole, or tower. The tree or vegetation must be located such that a failure of the tree or vegetation (or any part of the tree or vegetation) has a probability of causing damage to the utility line, pole, or tower. A "defect" is an injury or disease that seriously weakens the stems, roots, or branches of the tree or vegetation, predisposing it to fail (e.g., broken branches, split top) to continue standing. "Imminent" implies that damage resulting to the utility line, pole, or tower from the tree or vegetation could occur at any time. This definition applies to any vegetation that poses an immediate threat to a utility line. Hazard vegetation can include vegetation with arc potential (see Arc definition). Trees or vegetation with arc potential may be healthy with no defects predisposing them to imminent mechanical failure, but if vegetation is within arcing potential from a transmission or transmission line, it may pose a hazard. In order to eliminate hazards, pruning or removal of the hazard will be necessary.

Integrated Vegetation Management (IVM): A system of managing plant communities in which compatible and incompatible vegetation is identified, action thresholds are considered, control methods are evaluated, and selective controls are implemented to achieve a specific objective. Choice of control methods is based on effectiveness, environmental impact, site characteristics, safety, security, and economics.

Kilovolt (kV): 1,000 volts.

National Register of Historic Places: A national list of significant historic properties worthy of preservation, established under the National Historic Preservation Act of 1966. The list and its associated program are administered by the U.S Department of Interior's National Park Service for the purpose of coordinating and supporting public and private efforts to identify, evaluate, and protect America's historic and archaeological resources (cultural resources/historic properties).

Routine Vegetation Maintenance: The process of identifying and removing or pruning vegetation within the power line corridor for the purpose of providing safe, efficient, and reliable delivery of electricity. Proper clearance must be maintained at all times between power lines, trees, the ground, buildings, etc., taking into consideration a reasonable re-entry time between clearance cycles.

Span: The horizontal distance between two adjacent power poles.

Transmission Power Line: Heavy wires that carry large amounts of electricity at very high voltages over long distances from a generating station to a substation. Transmission voltages range from 69,000 to 500,000 volts (69 – 500kV).

Utility Vegetation Management: The process of managing vegetation surrounding utility lines for the purpose of providing safe, efficient and reliable delivery of electricity while minimizing vegetation related fires. Vegetation management includes routine vegetation maintenance, removing and pruning hazard vegetation, vegetation control around poles, structures, and other electric facilities. Vegetation management involves manual and mechanical treatment of vegetation, pre- and post inspections of vegetation, and disposal of vegetation.

APPENDIX 2: TIMBER MANAGEMENT GUIDELINES

The following guidelines have been extracted from the Utility Vegetation Management Guidelines in Utility Corridors in Arizona document (November 28, 2006) Appendix G:

Tree Designation & Removal:

The utility shall identify (with a paint dot on each tree at dbh unless otherwise specified by the agency) trees needing to be removed for safety reasons. Forest Service (FS) will visit the area, mark (below stump marks), measure and cruise the trees, calculate volume, and prepare billing (if appropriate) for timber to be removed. If the Utility is billed, payment must be received prior to cutting of trees.

Each National Forest will determine whether conditions warrant billing for timber to be removed. In general, in operable areas, there WILL be a charge for green timber proposed for cutting. The Utility may also be billed for recent dead trees that are still merchantable. Conditions to consider when making this determination are:

a). Any market value? Are there markets within the vicinity?
- See following text for value determination methods.
- Dead trees vs. Green trees (deterioration of dead wood over time)

b). Removal economical?
- Sufficient volume/acre
- Size of trees removed. Larger diameter = greater value.

c). Timber accessible?
- Inaccessible = No charge

If trees are inaccessible, have no market value, are not economical to harvest, and are not utilized; there will be no charge. No timber permit or contract is required for trees meeting these criteria. Authorization to cut is contained within the special use permit.

Forest Service shall give written permission for work to begin and after review of operating areas, may place restrictions on timing of cutting and/or specify types of slash treatment required.

If a National Forest has determined that billing for the timber is appropriate, then each Forest must determine the payment rates for the timber. Options in determining the payment rates include (by priority):

a). Actual appraisal rates obtained through TEA appraisal program.

b). Comparison appraisal using actual appraisal rates from similar sales.

c). Minimum Rates – See current R3 Supplement to FSM 2431.31a

d). Standard Rates-Use of the standard rates is not recommended, due to inability to sell many green sales.

It is agreed that there will be no billing for any trees removed under 5 inches in diameter.

Removal provisions and required payment for Piñon-Juniper species shall be determined by each National Forest.

APPENDIX 3: INDUSTRIAL FIRE PRECAUTION PLAN

FIRE PLAN – EMERGENCY FIRE PRECAUTIONS

Contractor will restrict operations in accordance with the attached Emergency Fire Precaution Schedule. When there is a predicted change, Forest Service shall inform the Contractor by 6:00 pm, Mountain Standard Time, of the predicted change in the Industrial Fire Precaution Plan. The Contractor will be responsible for providing a manner of communication that will allow this to occur successfully (e-mail, cell phone, etc.). The Contracting Officer may, after consultation with the Forest Supervisor, adjust the predicted Industrial Fire Precaution Plan for local weather conditions on project area. Changes in the predicted Industrial Fire Precaution Plan shall be agreed to in writing.

EMERGENCY FIRE PRECAUTION SCHEDULE	
FIRE RESTRICTION/CLOSURE "STAGE"	
"STAGED" RESTRICTION LEVELS	INDUSTRIAL FIRE PRECAUTION PLAN
NO RESTRICTIONS	A
STAGE I	B
STAGE II	C
PARTIAL / FOREST CLOSURE	D
RED FLAG WARNING (Issued by National Weather Service)	D

Staged restriction levels are determined by the Line Officer in conjunction with Fire Management Officer(s) and Contracting Officer(s). The process is a mix of quantitative and subjective measures which allows Line Officers a broad level of discretion considering local conditions and issues when deciding to implement fire restrictions and/or area closures.

INDUSTRIAL FIRE PRECAUTION PLAN - DESCRIPTION

A - Normal Fire Precautions – No fire guard required.

B - Normal Fire Precautions – except designated areas for smoking and warming or cooking fires require a written permit. Contractor will provide fire guard.

C - All power saws and mechanized equipment will shut down from 9:00 am until 8:00 pm Mountain Standard Time. Machinery maintenance and repair is authorized to continue from 12:00 noon until 2:00 pm, Mountain Standard Time, on pre-approved sites cleared to mineral soil. Shutdown from 12:00 noon until 8:00 pm Mountain Standard Time; all machine treatment of slash; mechanical equipment used for cutting, masticating and mulching; welding; and metal cutting. No smoking, warming or cooking fires are permitted at any time. Contractor will provide fire guard.

D - Shutdown all operations; except operations on mineral soil and with special Forest Service permit. Contractor will provide fire guard.

APPENDIX 4: PROJECT SPECIFIC TREATMENT TRACKING

This appendix will be used to track specific treatment protocol and requirements for each re-entry for vegetation maintenance on 500-2. The CMP will be reviewed prior to each cycle of work and any specific protocols and requirements that apply to the current cycle but are not specified in the CMP will be tracked below. This section will also be used to track specific treatment information during or following project implementation as seems appropriate.

For each cycle of work, include the year vegetation maintenance is scheduled, a list of the items that apply which includes a description of what is required and the location, and obtain signatures for APS from the Forestry Leader or Manager and for CNF from the District Ranger or Forest Supervisor. Signatures are inputted in the CMP Change Tracking Table at the beginning of the document.

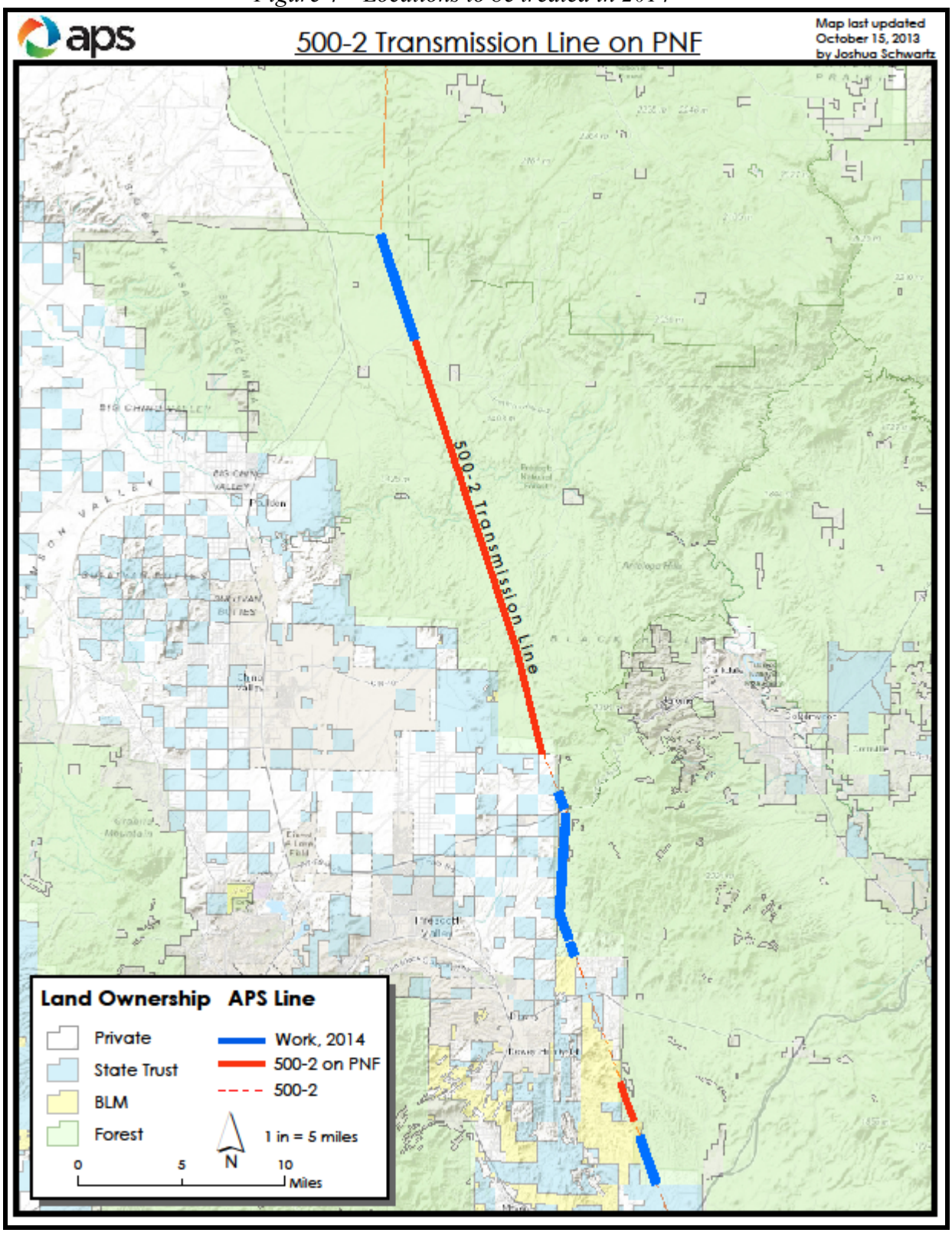
2014 PROJECT SPECIFIC TREATMENTS

Treatment Methods: APS proposes to mow 15.19 miles of vegetation on PNF in 2014. This line was initially cleared in 2009, and the 2014 treatment will include touch-up on any re-growth in the ROW to keep up with the current clearing; the work will be fairly minimal. Areas to be mowed are highlighted in blue on the map below (figure 2). Hand crews are likely to assist.

Timber: As this line was initially cleared in 2009, a timber tally will not be required for the 2014 cycle of work.

Heritage Resources: A total of 31 archaeological sites are located within the portion of the ROW proposed for treatment in 2014. Five of these sites have been recommended as not eligible for inclusion in the NRHP and no additional preservation or avoidance is required. The remaining 26 sites have been recommended as eligible for inclusion in the NRHP or are of indeterminate eligibility. These sites would be flagged and avoided by the mower. Any vegetation treatments required within the flagged area would be done by hand-crews with chainsaws. Any hand-cutting within the boundaries of AR-03-09-01-1282 will be monitored by a qualified archaeologist. Fire sensitive sites (05-221, 05-500)?

Figure 4 – Locations to be treated in 2014



Arizona Public Service
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Kaibab, AZ 86301
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APS Transmission Line Corridor Management Plan for Vegetation Management
500-2 Navajo-Westwing Transmission line

January 9, 2014

Kaibab National Forest

Prepared By
Joshua Schwartz
Arizona Public Service
In collaboration with the Kaibab National Forest

Table of Contents

CMP CHANGE TRACKING TABLE

Any minor or major revisions to the CMP and appendices following initial authorization and signature must be tracked in this table. For each version, change the version number on the title page. For APS Forestry, only Natural Resource Specialist, Forestry Leader, or Department Manager is authorized to approve changes. For KNF, only District Ranger or Forest Supervisor is authorized to approve. Any major or significant revisions must be approved by APS and Forest Supervisor at the discretion of each party. For each change, the last signer must input the date signed in the Effective Date column.

Version	Effective Date	Description	Revised By	Approved By			
					Date	Signature	Name
				APS			
				KNF			
				APS			
				KNF			
				APS			
				KNF			
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INTRODUCTION

This Transmission Line Corridor Management Plan (CMP) describes the procedures proposed by Arizona Public Service (APS) for the management of vegetation (utility vegetation management) along the 500-2 transmission line on the Kaibab National Forest (KNF). Once approved, the CMP is in place for the life of the permit or until a significant change to vegetation management practices, a change to APS or KNF policy, or other significant event triggers the need for a new CMP or major revisions. This CMP may be cancelled at any time according to the discretion of either KNF and/or APS. This CMP is to be reviewed prior to each cycle of routine vegetation maintenance by APS and KNF.

The vegetation management of this power line will involve routine vegetation maintenance and hazard vegetation treatments, and follow-up routine vegetation maintenance scheduled cyclically approximately every five years. This operating plan describes the proposed actions for these maintenance activities on KNF, the conservation measures that will be implemented for these activities, the clearance standards for the maintenance of this power line, and the specialist reports that have been conducted for the line.

Industry standards, regulations, and recommendations governing maintenance include: ANSI A300 Part 1-1001; A300 Part 7-2006; ANSI Z133; ANSI 2006; OSHA (29 CFR 1910.269); NESC 2007; RUS (USDA 7 CFR Part 1738); FERC; and the Arizona Corporation Commission.

This operating plan was developed in accordance with the Guidelines for Vegetation Management in Utility Corridors in Arizona (UVM Guidelines), and USFWS Biological Opinion # AESO/SE 22410-2007-F-0365.

CMP MANAGEMENT

PROJECT SPECIFIC TREATMENT PROCESS

For each individual cycle of work, specific treatments may be needed for only that cycle, but may not apply for future cycles. Prior to each cycle of work, this CMP will be reviewed to determine if any Project Specific Treatments will be needed. All project specific treatments will be determined in coordination between APS and a KNF representative and documented in Appendix 5: Project Specific Treatment Tracking. Project Specific Treatments will be approved by the appropriate representatives from APS and KNF.

These items will always be discussed for specific treatments prior to each cycle of work, though there may be other items that apply:

1. Specific slash disposal or chipping at road or trail crossing
2. Vegetation buffers at road crossings

3. Access routes to the lines and specific measures to be followed at access routes where applicable
4. List sensitive areas other than what is already included in the CMP and what is required at that location.
   Sensitive areas may include:
   a. Species restrictions or stipulations other than what is covered in the Conservation Measures section
   b. Timing or access restrictions due to other circumstances (e.g. a certain area is closed for work during May because of high public use)
   c. Areas of visual concerns with specific requirements, including trails, roads, and scenic view sheds

WORK OVERSIGHT

In order to ensure that all items in this CMP are communicated, understood, and followed by the APS employees and contractors involved in vegetation maintenance of the 500-2 line, APS will ensure the following actions occur prior to implementation of vegetation maintenance work:

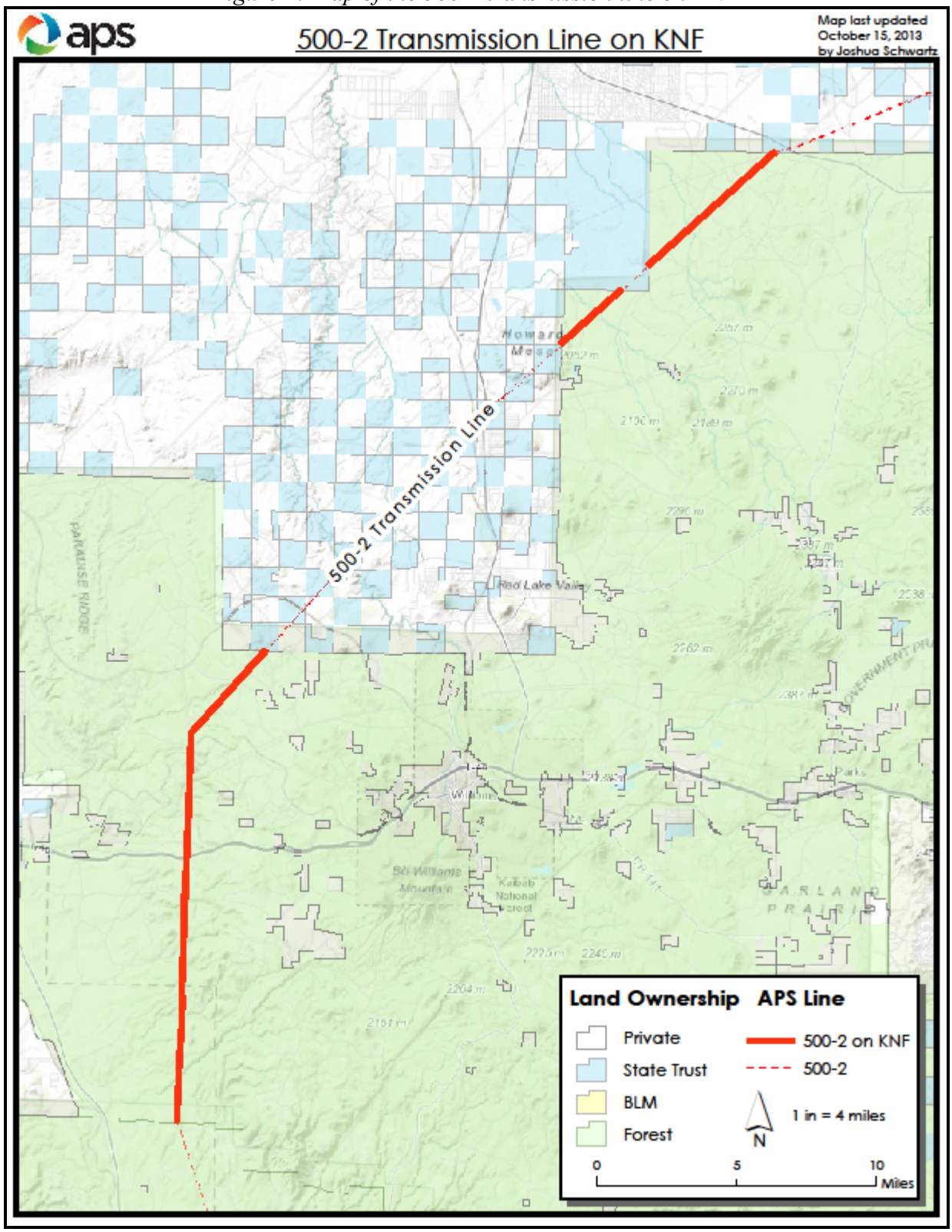
1. A map of the project, called the project map, will be provided to the crews prior to work showing all special treatment areas if applicable; these may include work type (mow or hand crew), conservation measure areas, areas where visual buffer is needed and any sensitive area that requires specific mitigation or change in standard protocol.
2. The APS Natural Resource Specialist assigned as liaison with the KNF will review all project specifications and requirements from this CMP and project map (if applicable) with the APS Forestry Leader, Planner, or Coordinator in charge of project implementation.
3. The Leader, Planner, or Coordinator will review all project specifications and requirements from this CMP and project map (if applicable) with the work crews and obtain sign-off that the crews understand the project requirements. The agency will be notified of the date of this meeting and may choose to attend.
4. The Leader, Planner, and/or Coordinator will make periodic site visits during work implementation to check on work and ensure work is conducted as agreed upon with KNF.
5. Upon completion of the work, the Leader, Planner or Coordinator will conduct an audit to verify that the work was completed correctly

GENERAL DESCRIPTION

The 500-2 Navajo-Westwing transmission line begins at the Navajo generating station in Page, AZ and feeds into the Westwing substation in Phoenix, AZ. This double-circuit transmission line is 205[1] miles in length, with 26.91 miles occurring on KNF. **K-13** is the special use permit issued to APS by KNF for this transmission line. The permit is due to expire on **3/30/2022**. The Right-of-Way (ROW) for this line is **330** feet wide with a total of 328 acres on KNF. Figure 1 shows the location of this transmission line on KNF.

[1] The 500-2 is a double circuit – this means there are 2 circuits that run in parallel. All calculations in this CMP have been made using the length of a single circuit. For example, the total length of both circuits on KNF is 53.82 miles. 53.82/2 = 26.91 miles. This same single-circuit method was employed for all area and length calculations in this CMP.

Figure 1: Map of the 500-2 transmission line on KNF



There are multiple vegetation types along the transmission line on KNF. Table 2 below lists each vegetation type and the length in miles of transmission line within that vegetation type.

Table 2: Vegetation Type along the APS Transmission Lines on KNF

Vegetation Type	Length in Miles
Great Basin Grassland	4.66
Piñon Juniper Woodland	21.78
Ponderosa Pine	0.47
Grand Total	**26.91**

OPERATIONAL PROCEDURES

APS proposes to maintain the vegetation along the transmission power line that could interfere with the lines or could become a fuel load issue along the line on KNF. The vegetation management process includes the clearing of vegetation within the ROW on a routine cyclical basis approximately every 5 years, as well as the occasional removal of hazard trees within or outside the ROW (sees Hazard Tree definition in Appendix 1 and the Hazard Vegetation section below for details). As the vegetation maintenance (also referred to as clearing) prescription is followed, the corridor should be converted to low growing plant communities that do not interfere with overhead power lines, pose a fire hazard, or hamper access.

VEGETATION CLEARING PRESCRIPTION

The overall vegetation clearing treatment prescription will include the following actions. The biological, cultural, and vegetation conservation measures and mitigations listed below under the Conservation Measures and Mitigations section also apply to vegetation clearing work.

1. APS will conduct vegetation clearing in 2014 following approval of this CMP and coordination with the KNF.
2. For future cycles of vegetation clearing, APS will contact the KNF liaison 1 month in advance to coordinate project details and any changes in policy and/or natural resources for each maintenance cycle on transmission lines. APS will also coordinate with KNF on any cutting and/or trimming projects in riparian areas prior to work. Any cycle specific maintenance agreements will be tracked in appendix 5.
3. Vegetation clearing work will occur cyclically approximately every 5 years.
4. APS will cut down all tall growing vegetation and some lower growing woody vegetation within the line ROW. Tall growing vegetation includes piñon pine (*Pinus edulis*), juniper (*Juniperus spp.*) ponderosa pine (*Pinus ponderosa*) and oaks (*Quercus spp.*)

   a. To reduce fuel around the structures all woody shrubs will be cut within a 40 foot radius around each pole.
5. No herbaceous or grass species will be treated within the ROW or around poles.
6. Where lines span canyons and drainages, and where line height is such that clearance standards can be maintained, no treatment will take place unless it is needed to break up heavy fuel loads.
7. Pruning or removal of hazard vegetation may occur outside of the ROW (see hazard vegetation section).
8. If possible, and as long as minimum clearance requirements are met, vegetation will be retained as a visual buffer in the ROW near homes, private land and scenic highways.
9. Vehicles will not be used on saturated soils resulting from precipitation, or in riparian areas.
10. The use of any tracked vehicles will be reported and pre-approved by KNF prior to use.
11. Vegetation treatment activities will be done using manual hand crew methods and by mechanical mowers.
12. APS will follow the Utility Vegetation Management guidelines dated 11/28/2006.

MECHANICAL VEGETATION REMOVAL

Mechanical methods of vegetation removal within ROW corridors involve the use of a cutting device on an arm mounted on a tractor with tracks or rubber tires (called a mower) that cuts and masticates vegetation. The mower method of clearing vegetation is quick and cost effective in many areas and masticates the vegetation into small chipped pieces. Locations where mechanical mowing will be used will be determined prior to vegetation maintenance through coordination with each District to identify the best locations for mowing. Each mowing area will be identified on a map prior to work to be supplied to the KNF and to the maintenance crews. The prescription of treatment for each mowing area will be agreed upon between APS and each District possibly with coordination during a field visit.

The mower is operated by one driver and one grounds-person. The grounds-person directs the mower and may operate a chainsaw to cut trees that the mower is unable to access. A hand crew may also follow after the mower to clean up, scatter debris, and prune or remove trees that the mower could not access. All vegetation is masticated by the mower and left on site in the corridor piled no higher than four inches. APS plans to use up to two mowers for the clearing of this line. They will also follow a public safety plan that outlines safety measures to use when the mower may come close to public roads or recreation areas. This will entail signage and watchmen whose sole duty will be traffic control in areas where operations may be a hazard to the public.

VEGETATION DISPOSAL

The following methods will be used for disposing vegetation for this project:

1. APS will contact the KNF contact prior to each cycle of maintenance for specific details required for vegetation disposal. Disposal specifics may include varied treatment due to fuel loading, trails requirements, cultural requirements, and biological requirements.
2. Stumps from vegetation treatments shall be cut within 6 inches of the ground, or if possible cut flush with the ground.
3. No slash or logs will be placed within 25 feet of the high mark of streams or other bodies of water.
4. All areas with the potential for flowing water (culverts, ditches, washes, etc.) shall be kept free of slash, logs, and debris from tree cutting and pruning operations.
5. Logs will be left to the greatest length as safely possible where felled, except where other requirements override this.
6. If practical and depending on the severity of infestation and FS recommendations, trees with evidence of current beetle infestation will be removed off site.
7. Vegetation masticated: This method will be used in areas where mechanical treatments are used, unless resource concerns dictate otherwise.
    a. Slash and logs are masticated by the mower and spread across the ROW no deeper than 4 inches deep.
    b. Any vegetation that the mower cannot treat would be treated using manual methods and disposed of as discussed in number 1 above.

ACCESS ROUTES

APS will use established roads and access routes to approach the line and will remain within the ROW for conducting work. APS will not create any new roads or access routes to enter the power line ROW, and will make every effort to minimize impact. Vehicles may include ATVs, pickup trucks, dump trucks, and chippers. If power lines are not accessible by road, APS will drive to the nearest location and crews will walk in with the necessary equipment.

FIRE PREVENTION

During the late spring and summer of each year, KNF often places restrictions on specific activities to help prevent the ignition of forest fires. Appendix 4 is the KNF Industrial Fire Precaution Plan and lists the different stages of fire restrictions. APS agrees to coordinate with KNF during fire restrictions. APS and their contractors are committed to preventing fires and will do the following things during times of fire risk:

1. Only use clear fueling areas to fuel equipment.
2. APS will submit daily crew locations to dispatch
3. Vehicles with hot exhausts will avoid parking in areas of flammable vegetation.

4. Chainsaws with hot exhausts will be placed on vehicles or on mineral soil.
5. Smoking is not permitted at the work site.
6. Crews will keep the following equipment with them at all times:
    a. 1 fire tool on site per person (examples: Pulaski, shovel)
    b. Indian Pump filled with water

HAZARD VEGETATION DESCRIPTION

Occasionally, vegetation that could pose a hazard to the line or structures may be identified. This section describes the process that APS and KNF have agreed to implement in the case of hazard vegetation.

APS has identified three levels of hazard vegetation, each of which will be dealt with in different ways:

Level 1: Emergency Hazard

An emergency hazard situation may occur when:

a. Vegetation is arcing to the line
b. A tree or limb has grown into contact with the line resulting in power faults or a fire hazard
c. A tree or limb has bent due to snow load, wind, or other weather condition such that the limb is arcing or is in contact with the line
d. A tree has been uprooted due to environmental conditions; and when all or a portion of a tree falls onto the line or structures. When an emergency hazard situation occurs, APS must act immediately to eliminate the hazard no matter the weather or road conditions or time of day or year. In these situations, the information listed under "Hazard Reporting" shall be gathered and reported to the KNF contacts **after** the hazard is eliminated along with a description of what occurred.

Level 2: Imminent Threat Hazard

There are two types of imminent threat hazards:

1. A live or dead standing tree or vegetation predisposed to imminent mechanical failure which could damage a utility line, pole, or tower.

2. A tree or branch that has come close enough to the power line such that it poses a safety risk to the public and/or tree workers.

Imminent threat hazards shall be treated as soon as possible. They are typically identified during Forestry annual line patrols, but may also be identified during a line maintenance patrol, aerial patrol, or reported by a customer or the public, or identified while any other

type of work or patrol is conducted along the line. Once imminent threat hazards are identified, the information listed under "Hazard Reporting" is gathered and reported to the KNF contacts. KNF will have 2 business days to review the submittal.
If no response is received after 2 days, APS may proceed with the work. If reasonable and appropriate, and submitted within the review period, APS also agrees to implement any specific requirements identified by KNF (e.g. request regarding slash treatment). Because these trees pose an imminent threat, treatment may occur at any time and APS may be unable to follow specific timing restrictions associated with the area of work. During breeding seasons, per USFWS recommendations, APS will coordinate the timing of the hazard treatments so that work is consolidated into the least number of days of work and least number of trips in and out of sensitive species breeding areas in order to minimize the duration and frequency of disturbance.

Level 3: Off Cycle Hazards

This type of hazard includes any live or dead trees having defects that pose a future threat to the power line or structures and cannot be left untreated for the next growing season. These hazards do not pose an imminent threat but must be treated prior to the next growing season before they become an imminent threat. Treatment of Off Cycle trees may sometimes be scheduled around seasonal timing restrictions. Once an Off Cycle tree has been identified, APS will notify the KNF contacts with the information listed under "Hazard Reporting" and the timing and methods of treatment will be discussed between APS Forestry and KNF representatives.

Hazard Reporting

When APS identifies and treats any of the three levels of hazard vegetation, they will follow this process:

1. APS identifies the hazards and marks each for pruning or removal.

2. APS reports the hazard data to the appropriate KNF contact. The reporting and treatment timeframes for each level are:

    a. Level 1: Emergency Hazards: the reports are sent after the treatment is completed.

    b. Level 2: Imminent Threat Hazards: the reports are sent prior to work. KNF staff have 2 days to review and comment. If no comment is received by APS after the 2nd day, APS will proceed with treatment.

Level 3: Off Cycle Hazards: the reports are sent prior to work. APS coordinates with KNF staff to determine the most appropriate timing of treatment.

The following information is gathered for reporting to the KNF contacts:

1. The GPS location of the tree or vegetation.
2. The power line name and/or number.
3. It is noted whether the tree or vegetation is inside or outside of the ROW.
4. The status of the tree or vegetation (live or dead).
5. The species of the tree or vegetation.
6. Hazard vegetation is placed into one of the following size classes:
    a. 5 – 9" dbh
    b. 9 – 12" dbh
    c. 12 – 18" dbh
    d. 18 – 24" dbh
    e. 24" dbh or greater
7. The date the trees were marked.
8. The date of when the treatment action occurred.

TREATMENT METHODS

Certified line clearance tree workers will conduct all clearing and hazard work with hand tools (chain saws, hand saws, rope). Chippers may be used hauled by a dump truck or pickup truck. 2 to 30 tree workers may work on the line at one time.

SPECIALIST REPORTS

BIOLOGICAL ASSESSMENTS AND BIOLOGICAL OPINIONS

Biological consultation regarding impacts of vegetation maintenance on utility corridors to threatened and endangered species has been conducted for this line. The consultation was a programmatic process that assessed impacts to listed species on 5 National Forests in Arizona (Kaibab, Coconino, Prescott, Apache-Sitgreaves, and Tonto NFs). The Biological assessment is called "Phase II Maintenance in Utility Corridors on Arizona Forests" (referred to below as the Phase II Consultation) and was completed February 29, 2008 and submitted to FWS for their opinion. This consultation includes all utility maintenance related activities and assesses the effects of these activities on threatened, endangered, proposed, candidate species, and their critical habitat if designated. This consultation will be in effect for 10 years following completion of the Biological Opinion (BO). The BO was completed on July 17, 2008 (reference # AESO/SE 22410-2007-F-0365). The conservation measures and reporting requirements that resulted from this BO that apply to the vegetation management along the 500-2 line are listed below. All of these items will be followed in implementation of this project. On the 500-2 line general conservation measures as well as conservation measures for Tusayan rabbitbrush (*Chrysothamnus molestus*) apply. For future cycles of work, KNF will be responsible for

notifying APS of any sensitive areas where additional conservation measures would apply.

HERITAGE RESOURCES

The management goal for heritage/cultural resources is to avoid adverse effects to historic properties that are on, or may be eligible for the State and/or National Registers of Historic Places within the Area of Potential Effect (APE) for all APS maintenance activities.

The entirety of the 500-2 ROW on KNF has been completely surveyed for heritage resources, and the results reported in:

"A Cultural Resources Survey of 6,104.79 Acres of State and Federal Lands for the Arizona Public Service Company 500-2 (Navajo–Westwing) 500-kV Transmission Line between the Westwing Substation and the Navajo Indian Reservation Boundary, Maricopa, Yavapai, and Coconino Counties, Arizona" by E. M. Laurila, D. A. Bild, M. S. Foster, J. S. Courtright, C. North, and E. Davis. LSD Technical Report No. 075107 (500-2c), Logan Simpson Design Inc., 2011.

A total of 48 heritage resources were identified on the KNF. Prior to mowing the ROW, all National Register of Historic Places (NRHP)-eligible sites, or sites that have not been evaluated for NRHP eligibility, shall be flagged for avoidance by the mower(s) by a qualified archaeologist. Unevaluated sites shall be treated as eligible until such time as the KNF makes an eligibility determination on those sites. Linear in-use sites such as roads or power lines shall not be marked, as due both the nature of the vegetation maintenance activities as well as the nature of the sites themselves, those sites will in no way be affected by the proposed maintenance activities. Flagging involves establishing a 50-foot buffer around each site and placing pink and white flagging marked with "APS" using a black Sharpie-type marker around each site so that each flag is visible from the next. Flagged sites will be hand cut using crews with chain saws and the slash lopped and scattered on-site. At the direction of the KNF Archaeologist, sites deemed "fire sensitive" as defined in the USDA Region 3 FS Programmatic Agreement shall also be flagged and worked by hand crews. There will be no piling of slash at any time. A site table shall be provided to crews as a back-up in case flagging should disappear or be removed prior to the work being done. No mechanized mowing activities shall take place at any time within the boundaries of flagged sites. No vehicles shall enter flagged site boundaries except that they remain on existing roads. In order to avoid rutting, no work may take place during wet conditions as described elsewhere in this document.

Hand cutting is not a ground-disturbing activity that has the potential to adversely affect heritage resources and will proceed without additional survey, flagging, mitigation, or preservation measures.

APS through its archaeologist shall regularly communicate with the KNF Archaeologist regarding its activities as they involve heritage resources. Should any activities

inadvertently affect any heritage resources, or should previously unidentified heritage resources be discovered during the course of APS maintenance activities, all work in that specific location shall cease and the APS archaeologist shall immediately notify the KNF archaeologist to arrange for the appropriate treatment and disposition of that resource. Any disputes or problems that may arise shall be resolved through discussions between the KNF archaeologist and the APS archaeologist, with additional guidance from the Arizona State Historic Preservation Office or other mutually agreed upon parties as necessary.

Should any previously unidentified heritage (cultural) resources (including burials and/or cremations) be discovered during any phase of this project, all work at that specific location should immediately cease, steps should be taken by the contractor and/or APS personnel to protect the discovery, and the APS Archaeologist (602-371-5298 W. or 602-677-1747 C.) should be contacted immediately in order to make arrangements for the proper treatment of the discovery in coordination with the KNF Forest Archaeologist.

CONSERVATION MEASURES

Tusayan rabbitbrush (*Chrysothamnus molestus*)

The Forest Service sensitive plant, Tusayan rabbitbrush (*Chrysothamnus molestus*), is known to occur within the proximity of the 500-2 power line on the Kaibab National Forest. APS biologists will coordinate with Forest Service staff to educate field workers on Tusayan rabbitbrush for avoidance where possible prior to project implementation. APS will avoid impacts to this plant resulting from covering with mulch or slash, mowing, cutting, and driving over, where possible.

Tusayan rabbitbrush (*Chrysothamnus molestus)*

General Noxious Weed Best Management Practices to minimize impact to T&E Species

1. Ensure that utility mower, track, or other off-road equipment, which has high potential to carry noxious weeds (not including service vehicles, pick-up trucks, or passenger cars) is free of soil, weeds, vegetative matter or other debris that could harbor seeds prior to entering national forests.
2. Utilities will consult with the appropriate FS contact to identify known or high probability noxious weed hotspots. In those areas, the utilities will ensure that mower, track, or other off-road equipment, that have high potential to carry noxious weeds (not including service vehicles, pick-up trucks, or passenger cars) are free of soil, weeds, vegetative matter or other debris that could harbor seeds prior to moving equipment between line segments.

Repair of Access Route Best Management Practices

1. When feasible, safe, and efficient to conduct maintenance work or inspections, walk into areas that are inaccessible under current route conditions.
2. If traffic control structures are present (boulders, barriers, dips) and must be moved, return structures and configuration to original position/design when work is complete.
3. Prune vegetation where feasible, and minimize the amount of vegetation trimmed along access route.
4. Minimize soil disturbance to reduce erosion.
5. Minimize rutting and repair per coordination with appropriate FS District.
6. Staging areas for loading and unloading of equipment should be located in previously disturbed areas, but outside of floodplains and other wet areas.

Reporting Requirements

APS must provide annually (Jan 30 of each year the biological opinion is in effect) to the FS and FWS, a summary of the activities conducted under the proposed action and Biological Assessment. The information will be used to assess if the actions as implemented were accurately described and analyzed in the BA and BO, and that the effects of the action are not greater than anticipated.

Reporting of Hazard Vegetation Treatments:

The utilities shall provide a summary of hazard vegetation work activities as described in the proposed action for those species and/or critical habitat with “Likely to Adversely Affect” determinations. These species include the Mexican spotted owl (PACs and critical habitat), yellow-billed cuckoo (suitable and occupied habitat), and Southwestern willow flycatcher (occupied, suitable, and critical habitat). The summary shall include:

1. The GPS or geographic location of the tree(s) or vegetation.
2. The power line name and/or number.
3. The species and status of the tree (s) or vegetation (live or dead).
4. The size class of the tree (primarily applicable to MSO PACs and critical habitat).
5. The date the trees were located.
6. The number, size class, and species of trees that were damaged or removed due to felling the hazard tree or vegetation if applicable.
7. The date(s) of when the action occurred.
8. The wildlife or fish species and or their critical habitat in the vicinity of the action (i.e., MSO, cuckoo, flycatcher).

Reporting of Routine Vegetation Maintenance:

The utilities shall provide a summary of routine vegetation maintenance activities as described in the proposed action. The summary shall include:

1. The power line name and/or number.
2. A brief description of the activities conducted.
3. A start and end point of the area treated.
4. The dates of when the work was conducted.

Field Inspection of Treatment Activities

The Forest Service and Fish and Wildlife Service will annually schedule with the utilities, a patrol of selected sections of lines that were worked on during the previous year. Preferably, one terrestrial and one fisheries biologist from the FS and FWS that were on the Biological Assessment consultation team will attend the patrol. The purpose of the patrol will be to visually assess that the work conducted was in accordance with the description of the proposed action, and that the analysis of effects to the species was assessed appropriately in the BA.

Species Updates and Incorporation of New Information

The utilities will work with the FS, FWS, and Arizona Game and Fish Department (Heritage Data Management System), to annually update species information to ensure that new information is incorporated and assessed relative to the proposed action.

CONTACTS

The following is a list of contacts involved for vegetation management of distribution lines on KNF. The names included are those present for 2014. Future contacts may vary, though the job position for the contact should remain the same. All coordination for vegetation maintenance projects should be done through the KNF Liaison and APS Liaison. Coordination between specialists (e.g. biologist, forester, or archaeologist) should be conducted so that the liaisons remain informed on any discussion or agreement made.

APS CONTACTS

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NW Forestry Division Leader
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Jon Shumaker
Natural Resource Specialist/Archeologist
602-371-5298

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Deidre McLaughlin
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928-635-5662

SIGNATURES

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Joshua Schwartz
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Approved by: Tracy Moore **Date:** 11-22-13
Tracy Moore
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Arizona Public Service

Responsible Parties

Approved by: _____ **Date:** 1/21/2014
Mike Williams
Forest Supervisor
Kaibab National Forest

Appendix 1: Definitions

36 CFR 800: The Federal Advisory Council on Historic Preservation's regulations describing the process for implementing Section 106 of the National Historic Preservation Act, as revised.

ARPA: The Archaeological Resources Protection Act of 1979, as amended.

Arc: The flow of electricity across a gap (through the air) from one conductor to another or to a grounded object. Arcing potential is evaluated by using accepted industry standards such as the National Electric Safety Code.

Conductor: A wire, combination of wires, bus bar, rod or tube suitable for carrying an electrical current. When describing a power line, may often be interchangeably referred to as a power line, line, phase, circuit, wire, cable, or primary. Any material that allows electricity to be carried through it.

Cultural Resource: Definitions vary, but essentially any resource that is of a cultural character. Cultural resources encompass archaeological, traditional, and built environment resources including but not limited to buildings, structures, objects, districts, and sites.

Energized: Synonymous to "live" or "hot".

Energized Conductor: An electrically energized wire or other object that is conducting electricity.

Flashover: An unintended electrical discharge to ground or another phase. Flashovers can occur between two conductors, across insulators to ground or equipment bushings to ground. Caused by placing a voltage across the air space that results in the ionization of the air space.

Hazard Vegetation: Hazard vegetation is a live or dead standing tree or vegetation having defects, singly or combined, in the roots, butt, bole, or limbs, which predispose it to imminent mechanical failure to the whole or part of a utility line, pole, or tower. The tree or vegetation must be located such that a failure of the tree or vegetation (or any part of the tree or vegetation) has a probability of causing damage to the utility line, pole, or tower. A "defect" is an injury or disease that seriously weakens the stems, roots, or branches of the tree or vegetation, predisposing it to fail (e.g., broken branches, split top) to continue standing. "Imminent" implies that damage resulting to the utility line, pole, or tower from the tree or vegetation could occur at any time. This definition applies to any vegetation that poses an immediate threat to a utility line. Hazard vegetation can include vegetation with arc potential (see Arc definition). Trees or vegetation with arc potential may be healthy with no defects predisposing them to imminent mechanical failure, but if vegetation is within arcing potential from a transmission or transmission line, it may pose a hazard. In order to eliminate hazards, pruning or removal of the hazard will be necessary.

Integrated Vegetation Management (IVM): A system of managing plant communities in which compatible and incompatible vegetation is identified, action thresholds are considered, control methods are evaluated, and selective controls are implemented to achieve a specific objective. Choice of control methods is based on effectiveness, environmental impact, site characteristics, safety, security, and economics.

Kilovolt (kV): 1,000 volts.

National Register of Historic Places: A national list of significant historic properties worthy of preservation, established under the National Historic Preservation Act of 1966. The list and its associated program are administered by the U.S Department of Interior's National Park Service for the purpose of coordinating and supporting public and private efforts to identify, evaluate, and protect America's historic and archaeological resources (cultural resources/historic properties).

Routine Vegetation Maintenance: The process of identifying and removing or pruning vegetation within the power line corridor for the purpose of providing safe, efficient, and reliable delivery of electricity. Proper clearance must be maintained at all times between power lines, trees, the ground, buildings, etc., taking into consideration a reasonable re-entry time between clearance cycles.

Span: The horizontal distance between two adjacent power poles.

Transmission Power Line: Heavy wires that carry large amounts of electricity at very high voltages over long distances from a generating station to a substation. Transmission voltages range from 69,000 to 500,000 volts (69 – 500kV).

Utility Vegetation Management: The process of managing vegetation surrounding utility lines for the purpose of providing safe, efficient and reliable delivery of electricity while minimizing vegetation related fires. Vegetation management includes routine vegetation maintenance, removing and pruning hazard vegetation, vegetation control around poles, structures, and other electric facilities. Vegetation management involves manual and mechanical treatment of vegetation, pre- and post inspections of vegetation, and disposal of vegetation.

APPENDIX 2: TIMBER MANAGEMENT GUIDELINES

The following guidelines have been extracted from the Utility Vegetation Management Guidelines in Utility Corridors in Arizona document (November 28, 2006) Appendix G:

Tree Designation & Removal:

The utility shall identify (with a paint dot on each tree at dbh unless otherwise specified by the agency) trees needing to be removed for safety reasons. Forest Service (FS) will visit the area, mark (below stump marks), measure and cruise the trees, calculate volume, and prepare billing (if appropriate) for timber to be removed. If the Utility is billed, payment must be received prior to cutting of trees.

Each National Forest will determine whether conditions warrant billing for timber to be removed. In general, in operable areas, there WILL be a charge for green timber proposed for cutting. The Utility may also be billed for recent dead trees that are still merchantable. Conditions to consider when making this determination are:

a) Any market value? Are there markets within the vicinity?
- See following text for value determination methods.
- Dead trees vs. Green trees (deterioration of dead wood over time)

b) Removal economical?
- Sufficient volume/acre
- Size of trees removed. Larger diameter = greater value.

c) Timber accessible?
- Inaccessible = No charge

If trees are inaccessible, have no market value, are not economical to harvest, and are not utilized; there will be no charge. No timber permit or contract is required for trees meeting these criteria. Authorization to cut is contained within the special use permit.

Forest Service shall give written permission for work to begin and after review of operating areas, may place restrictions on timing of cutting and/or specify types of slash treatment required.

If a National Forest has determined that billing for the timber is appropriate, then each Forest must determine the payment rates for the timber. Options in determining the payment rates include (by priority):

a) Actual appraisal rates obtained through TEA appraisal program.

b) Comparison appraisal using actual appraisal rates from similar sales.

c) Minimum Rates – See current R3 Supplement to FSM 2431.31a

d) Standard Rates-Use of the standard rates is not recommended, due to inability to sell many green sales.

It is agreed that there will be no billing for any trees removed under 5 inches in diameter.

Removal provisions and required payment for piñon-juniper species shall be determined by each National Forest.

APPENDIX 3: INDUSTRIAL FIRE PRECAUTION PLAN

FIRE PLAN – EMERGENCY FIRE PRECAUTIONS

Contractor will restrict operations in accordance with the attached Emergency Fire Precaution Schedule. When there is a predicted change, Forest Service shall inform the Contractor by 6:00 pm, Mountain Standard Time, of the predicted change in the Industrial Fire Precaution Plan. The Contractor will be responsible for providing a manner of communication that will allow this to occur successfully (e-mail, cell phone, etc.). The Contracting Officer may, after consultation with the Forest Supervisor, adjust the predicted Industrial Fire Precaution Plan for local weather conditions on project area. Changes in the predicted Industrial Fire Precaution Plan shall be agreed to in writing.

EMERGENCY FIRE PRECAUTION SCHEDULE	
FIRE RESTRICTION/CLOSURE "STAGE"	
"STAGED" RESTRICTION LEVELS	**INDUSTRIAL FIRE PRECAUTION PLAN**
NO RESTRICTIONS	**A**
STAGE I	**B**
STAGE II	**C**
PARTIAL / FOREST CLOSURE	**D**
RED FLAG WARNING **(Issued by National Weather Service)**	**D**

Staged restriction levels are determined by the Line Officer in conjunction with Fire Management Officer(s) and Contracting Officer(s). The process is a mix of quantitative and subjective measures which allows Line Officers a broad level of discretion considering local conditions and issues when deciding to implement fire restrictions and/or area closures.

INDUSTRIAL FIRE PRECAUTION PLAN - DESCRIPTION

A - Normal Fire Precautions – No fire guard required.

B - Normal Fire Precautions – except designated areas for smoking and warming or cooking fires require a written permit. Contractor will provide fire guard.

C - All power saws and mechanized equipment will shut down from 9:00 am until 8:00 pm Mountain Standard Time. Machinery maintenance and repair is authorized to continue from 12:00 noon until 2:00 pm, Mountain Standard Time, on pre-approved sites cleared to mineral soil. Shutdown from 12:00 noon until 8:00 pm Mountain Standard Time; all machine treatment of slash; mechanical equipment used for cutting, masticating and mulching; welding; and metal cutting. No smoking, warming or cooking fires are permitted at any time. Contractor will provide fire guard.

D - Shutdown all operations; except operations on mineral soil and with special Forest Service permit. Contractor will provide fire guard.

APPENDIX 4: PROJECT SPECIFIC TREATMENT TRACKING

This appendix will be used to track specific treatment protocol and requirements for each re-entry for vegetation maintenance on 500-2. The CMP will be reviewed prior to each cycle of work and any specific protocols and requirements that apply to the current cycle but are not specified in the CMP will be tracked below. This section will also be used to track specific treatment information during or following project implementation as seems appropriate.

For each cycle of work, include the year vegetation maintenance is scheduled, a list of the items that apply which includes a description of what is required and the location, and obtain signatures for APS from the Forestry Leader or Manager and for KNF from the District Ranger or Forest Supervisor. Signatures are inputted in the CMP Change Tracking Table at the beginning of the document.

2014 PROJECT SPECIFIC TREATMENTS

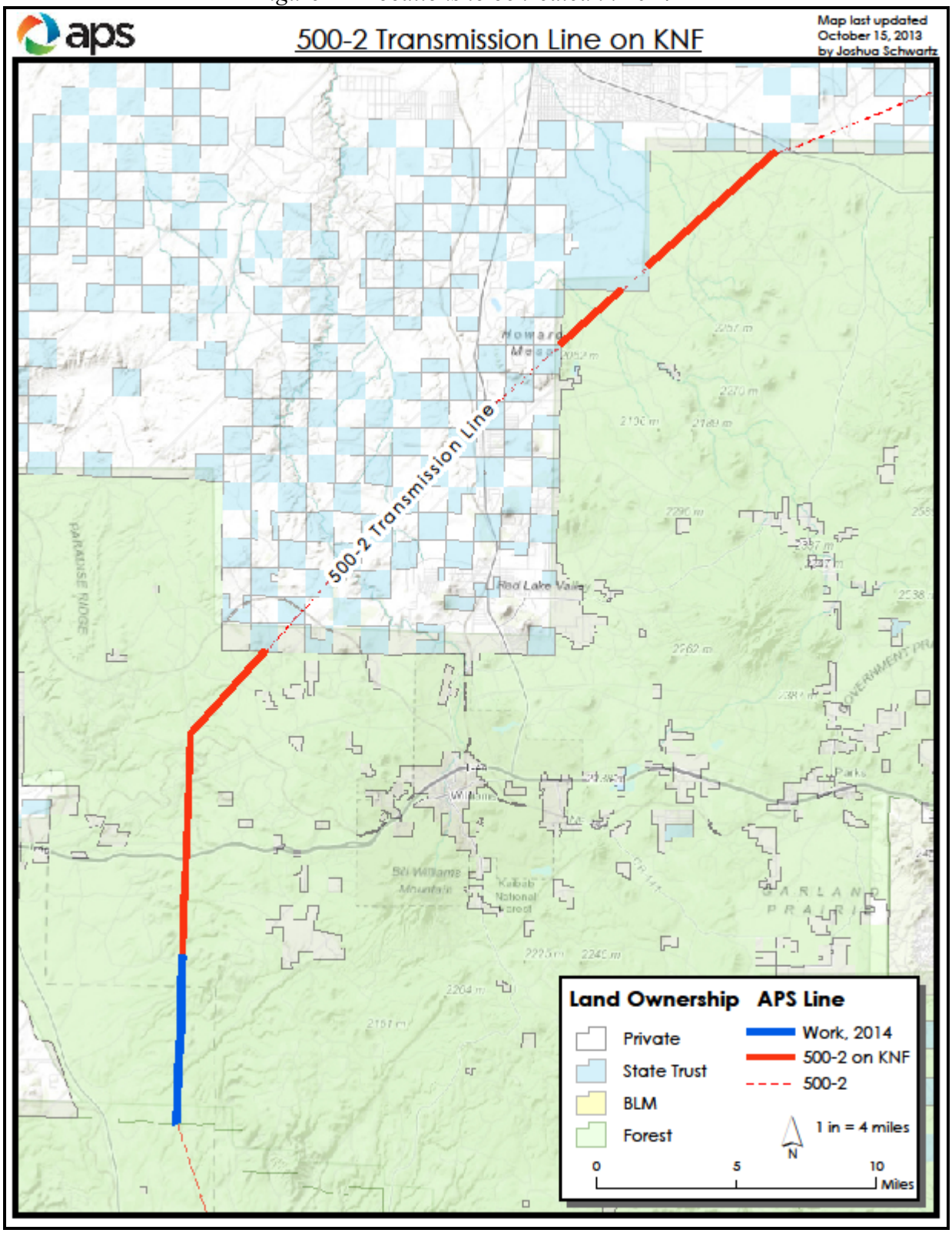
Treatment Methods: APS proposes to mechanically mow 6 miles of vegetation on KNF in 2014. This line was initially cleared in 2009. The 2014 prescription intends to maintain the cleared ROW and is generally touch-up work to treat any re-growth since 2009. The area to be mowed is highlighted in blue on the map below (figure 2); hand crews may also assist.

Timber: As this line was initially cleared in 2009, a timber tally will not be required for the 2014 cycle of work.

Heritage Resources: A total of 11 archaeological sites are located within the portion of the ROW proposed for treatment in 2014. Two of these sites have been recommended as not eligible for inclusion in the NRHP and no additional preservation or avoidance is required. The remaining 9 sites have been recommended as eligible for inclusion in the NRHP or are of indeterminate eligibility. These sites would be flagged and avoided by the mower. Any

vegetation treatments required within the flagged area would be done by hand-crews with chainsaws. Fire-sensitive sites in the proposed treatment area include site #s: AR-03-07-01-2686, 01-2688, and 01-2690.

Figure 2 – Locations to be treated in 2014



Arizona Public Service Company

Herbicide Corridor Management Plan & Biological Assessment and Evaluation for Transmission Herbicide Project on the Navajo Nation & Big Boquillas Ranch

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Table of Contents

Introduction

Arizona Public Service (APS) Transmission Herbicide Project is in furtherance of the vegetation management efforts that APS has undertaken in order to maintain compliance with the North American Electric Reliability Corporation (NERC) Reliability Standard FAC-003. Since 2007 when the FAC-003 standard was implemented, APS has been conducting mechanical and hand clearing vegetation management projects across its transmission system within the rights-of-way (ROW). The Transmission Herbicide Project is an effort to maintain the required clearances that have been achieved through these previous efforts.

APS is committed to implementing the best integrated vegetation management (IVM) solution utilizing industry accepted (ANSI A300, Part 7) best management practices to maintain compliance with the FAC-003 standard. Implementing the Transmission Herbicide Project subsequent to the hand and mechanical operations will significantly decrease the impact to the natural resources, species of concern, and culturally significant properties by decreasing the frequency and intensity of future maintenance operations required to remain compliant with the FAC-003 standard.

Proposed Activity

APS Forestry and Special Programs, with the approval and support of the Navajo Forestry Department, propose to implement herbicide treatments on transmission lines running across the Navajo Nation, Navajo-Hopi Joint Use Area and the Big Boquillas Ranch. Project implementation is proposed for September 12, 2011 through November 30, 2011 with a follow up application August 15 through November 30, 2012. The project area includes the ROW for three existing APS transmission lines on Navajo Nation lands (Table 1). Three additional APS transmission lines within the Navajo Nation (lines 230-1, NE-1 and NE-5) are excluded from this evaluation.

Transmission Line Acres & Miles

Power Line	Acres	Miles
345-1	5239	137
500-1	3339	138
500-1 Big Boquillas	612	30
500-2	3828	96

All herbicide applications will be spot treatments utilizing backpack, handheld, and quad/ATV mounted sprayers with a support vehicle. Herbicides will be applied from a backpack or a quad/ATV mounted sprayer using a spray wand, allowing for plant specific treatments. Targeted vegetation includes any species less than 10 feet tall whose physiology is such that it could potentially impact the reliability of the transmission line, the associated transmission facilities (e.g. towers, guy wires, etc.), or poses a fire fuel load concern. Typical vegetation to be treated include juniper (*Juniperus* spp.), oak (*Quercus* spp.), pine (*Pinus* spp.), Russian olive (*Elaeagnus angustifolia*) and saltcedar (*Tamarix chinensis*) trees less than 10 feet tall, or sagebrush (*Artemisia* spp.) and other shrubs at the base of towers or where their densities pose a fire fuel load concern.

The support vehicle will be available at intervals along the line to load the chemical sprayers and will only be driving on pre-existing roads within the ROW. The herbicides to be applied are contained in sealed pre-mixed "ready to use" formulations. There will be no chemical mixing on site, minimizing or eliminating the potential to spill chemicals. The herbicide containers are tracked using a bar code system and are returned to the supplier after use. There will be no waste disposal of chemical jugs or packaging required as part of this project.

APS also proposes to treat any invasive species encountered during the course of the project within the ROW where it is reasonable and prudent to do so, provided the herbicide being applied would be an effective treatment.

Initial herbicide applications are scheduled from September 12 to November 30, 2011 with a follow up application to be conducted August 15 through November 30, 2012. Future maintenance herbicide applications will be assessed annually and submitted for review and approval when vegetation growth is sufficient to warrant another application.

All activities will be conducted within existing APS transmission line ROW. Crews will use established roads and access routes to reach the ROW. There will be no new roads or access routes required for this project. APS will make every effort to keep impacts within the ROW to a minimum. APS will only work within the ROW when the soils are dry enough to prevent ruts, and will avoid any support vehicle or quad/UTV traffic in riparian areas unless there is an established road. If a portion of the transmission line ROW is inaccessible by road or sensitive habitats occur within the ROW, the crew will drive to the nearest location and walk in to the ROW with the necessary equipment. All vehicles will be operated in a safe and prudent manner during daylight hours, maintaining speeds of 15 to 20 miles per hour within the ROW.

Chemicals & Rates

The following products will be applied as the chemical treatment. Thinvert, a paraffinic oil, will be the carrier and has little to no drift during application allowing for very target specific treatments. Specific chemical mixes will be used for upland species and aquatic species.

Northern Upland Mix

Chemical	Active Ingredient	Rate (% total volume)	EPA Registration #
Garlon 3A	**Triclopyr**	**4%**	**62719-37**
Milestone VM	**Triclopyr & Aminopyralid**	**<1%**	**62719-572**
Escort XP	**Metsulfuron Methyl**	**<1%**	**352-439**
Thinvert	**Paraffinic Oil**	**94%**	**NA**

Aquatic Mix

Chemical	Active Ingredient	Rate (% total volume)	EPA Registration #
Habitat	**Imazapyr**	**7%**	**241-426**
Accord	**Glyphosate**	**2%**	**62719-517**
Thinvert	**Paraffinic Oil**	**91%**	**NA**

Storage and Disposal

The *Aquamix* system employed by the contractor is a closed system. Each container has a bar code attached to it that is tracked from the day it is shipped to the day it is returned empty. All products are pre-mixed to the projects specifications (listed above) and all containers are returned to the supplier when empty. There is no waste disposal or onsite chemical mixing associated with this project.

Site Safety

All applicable labels, federal and state laws, and regulations with regard to the use and application of herbicides will be strictly adhered to. Applicators will wear the maximum PPE required per the label for each herbicide being applied including but not limited to long sleeved shirts and pants, gloves, socks, and boots. Those operating the quad/UTV mounted sprayers will also be required to wear goggles or safety glasses and helmets. Tailgate safety meetings will be conducted each morning or when the crew is moved to a new location.

MSDS and labels will be on site at all times and all safety precautions listed on the product labels shall be strictly adhered to. Each crew will consist of licensed herbicide applicators and at least one crew member will have a minimum of three years experience applying herbicides. Crews working on the project will have telephones, chemical spill kits, shovels, first-aid kits, fresh water, and emergency phone numbers with them.

Contractor Personnel

The primary contractor for the APS Transmission Herbicide Project is Southwest Ground Control, LLC, Arizona Office of Pesticide Management company license number 5349.

Ron Romero QP# 1822
Southwest Ground Control
255 E Corporate Place
Chandler, AZ 85225
480.922.9278 office
480.797.2254 cell

Personnel include:
Ron Romero, 480.797.2254
Leovardo Moreno, 480.797.2671
Eric Warchol, 480.748.6617
Walter Romero, 602.421.1954
Paul Langford, 480.343.0219

Action Area

The project is located along the 345-1, 500-1, and 500-2 transmission lines in northeastern Arizona and northwestern New Mexico. The project area occurs on the Navajo Indian

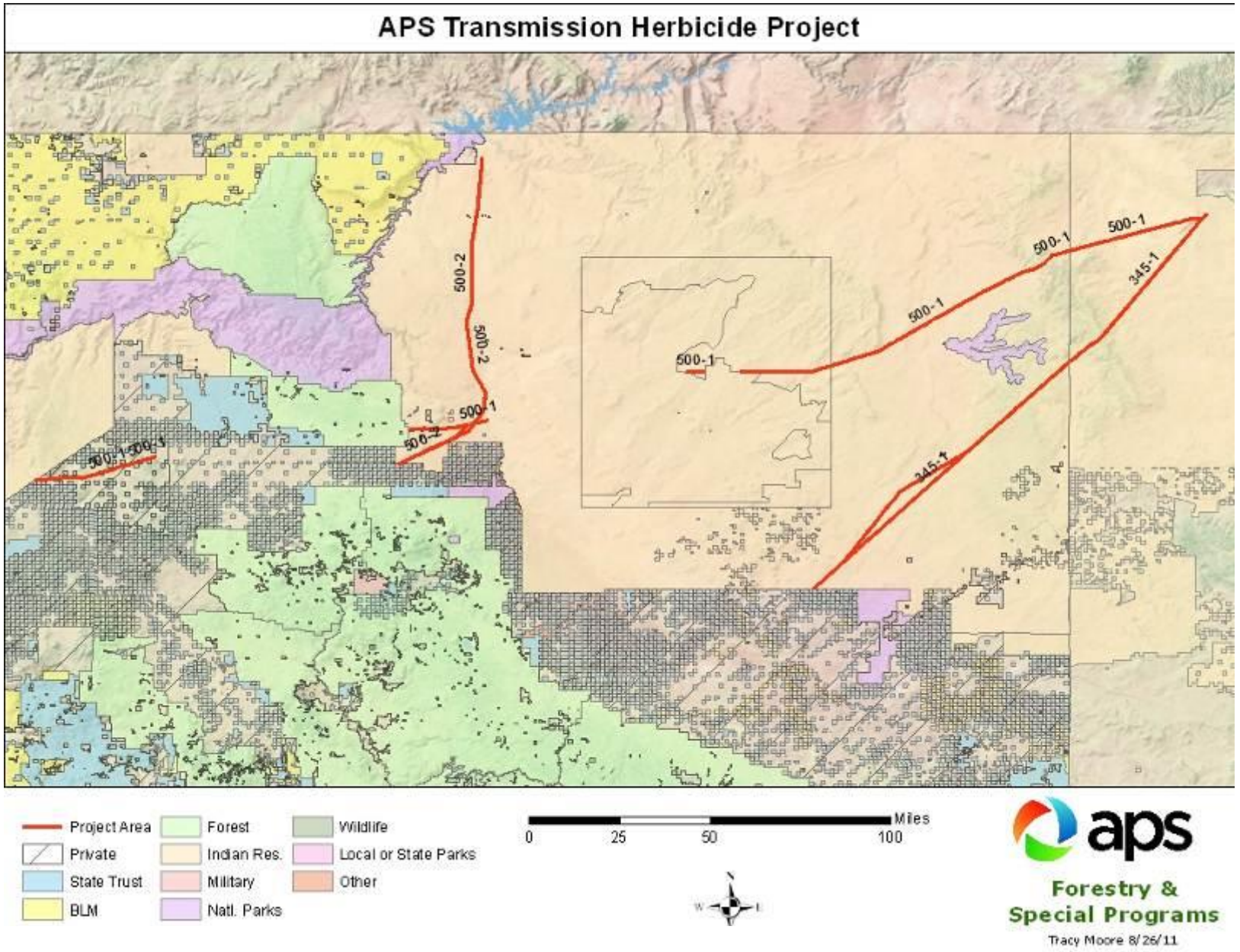
Reservation in San Juan County, New Mexico and in Apache, Navajo, and Coconino counties in Arizona and on the Big Boquillas Ranch in Coconino County, Arizona from approximately 4,200 feet to 9,000 feet above mean sea level (msl). See Map 1.

The project area is located within the Great Basin Desertscrub, Plains and Great Basin Grassland, Great Basin Conifer Woodland, and the Petran Montane Conifer Forest biotic communities (Brown 1994).

The 345-1 and the 500-1 transmission lines begin approximately 5 miles south of Waterflow, New Mexico. The 345-1 project area extends 137 miles southwest and crosses the Chuska Mountains at the New Mexico-Arizona border, continues to the Defiance Plateau, and ends approximately 19 miles north of Holbrook, Arizona. The 500-1 transmission line extends in a more westerly direction, crossing the Chuska Mountains, Chinle Valley, and Black Mesa. The 500-1 line crosses through the Hopi Indian Reservation back on to the Navajo Nation just at the Little Colorado River and extends approximately 15 miles west of Cameron. An additional portion of the 500-1 line included in this evaluation is within the Big Boquillas Ranch, north of Seligman, Arizona at the Aubrey Cliffs. The 500-1 line project area totals 138 miles in length. The 500-2 project area extends for approximately 96 miles beginning east of Page, Arizona, and continuing south to The Gap, Arizona, and crosses the Little Colorado River. The 500-2 line splits into two separate lines south of Cameron, Arizona and reconvenes 5.5 miles to the southwest. All proposed work will occur within and adjacent to the existing APS ROW. Access to the project site will be by existing road and the transmission line corridor. The 345-1 and 500-2 transmission line corridors are double circuit corridors with two sets of transmission towers in each corridor.

Within the project area, the Great Basin Desertscrub biotic community is found from 4,100 feet to 6,100 feet in elevation and occurs most often in the western portion of project area. Dominate vegetative species in this community include sagebrush, shadscale (*Atriplex convertifolia*), and blackbrush (*Coleogyne ramosissima*). Other species occurring within this community include: winterfat (*Ceratoides lanata*), snakeweed (*Gutierrezia sarothrae*), rabbitbrush (*Chrysothamnus nauseosus*), greasewood (*Sarcobatus vermiculates*), cholla and prickly pear cacti (*Opuntia* spp.), hedgehog (*Echinocereus triglochidiatus*), and various other cacti (*Sclerocactus* spp. and *Pediocactus* spp.). Introduced Russian olive and saltcedar may be scattered along dominate washes and drainages (Brown 1994).

The Plains and Great Basin Grassland biotic community is widespread across the project area, often coming in contact with the Great Basin Desertscrub and Great Basin Conifer Woodland biotic communities. Within the project area, the Plains and Great Basin Grassland biotic community ranges from 5,200 feet to 6,600 feet in elevation, and consists of open, grass-dominated high level plains, valleys, and hillsides. Vegetative species found in this community include: blue grama (*Bouteloua gracilis*), galleta grass (*Pleuraphis jamesii*), and rice grass (*Oryzopsis hymenoides*), four-wing saltbush (*Atriplex canescens*), sagebrush, winterfat, cholla (*Opuntia* spp.), soapweed (*Yucca glauca*), snakeweed, and rabbitbrush (Brown 1994).


APS Transmission Herbicide Project
500-2
500-1
500-1
500-1
500-1
345-1
500-1
500-2
500-1
500-2
500-1
345-1
Project Area
Private
State Trust
BLM
Forest
Indian Res.
Military
Natl. Parks
Wildlife
Local or State Parks
Other
Miles
0
25
50
100
aps
Forestry &
Special Programs
Tracy Moore 8/26/11

The Great Basin Conifer Woodland biotic community is found on the Arizona-New Mexico border in the Chuska Mountains, but is also found widespread throughout the project area. The elevation for this community ranges from 5,600 feet to 7,700 feet in elevation. The dominant vegetative species in this community includes pinyon pine (*Pinus edulis*) and juniper (*Juniperus osteosperma*), big sagebrush (*Artemisia tridentata),* and blackbrush. Other shrubs and grasses present include: snakeweed, rabbitbrush, Mormon-tea (*Ephedra viridis*), blue grama, galleta grass, and rice grass (Brown 1994).

Within the project area, the Petran Montane Conifer Forest biotic community is limited to the Arizona and New Mexico border at the Chuska Mountains and just south of Canyon de Chelly National Monument. The elevation for this community within the project area falls between 6,650 feet and 8,500 feet. The vegetative species occurring within the Petran Montane Conifer Forest include Ponderosa Pine *(Pinus ponderosa),* Douglas fir (*Pseudotsuga menziesii*), quaking aspen (*Populus tremuloides*), Gambel oak (*Quercus gambelii*), creeping mahonia (*Mahonia repens*), fendler ceanothus (*Ceanothus fendleri*), wheatgrass *(Agropyron* spp.*),* muly grasses (*Muhlenbergia* spp.), and Arizona fescue *(Festuca arizonic*) (Brown 1994).

Biotic community classifications are general in nature and do not fully describe the discrete community characteristics of the project limits. While the vegetation communities that occur along these corridors generally fall into these broad descriptive categories, there are marked differences in vegetation species composition and community physiognomy. These differences can be attributed to ongoing transmission line maintenance activities including vegetation management, structure repair and maintenance, and line maintenance. These activities have changed the natural quality of the environment within the right-of-way corridor. As a result, the transmission line corridor is open, dominated by native grasses, and lacks tall, mature trees and densely growing shrubs. Under the transmission line, grasses may include: Mountian muhly (*Mulenbergia montana*), gramas (*Bouteloua* spp.), wheatgrass, and squirrel tail (*Elymus elymoides*). Scattered, low growing shrubs under the transmission line may include: sage brush, snakeweed, rabbitbrush, and cliffrose (*Purshia subintegra*). Seedling, sapling, and re-sprouting trees and brush under the transmission line may include: Ponderosa Pine, Aspen, Oaks, Junipers, and Arizona Cypress (*Cupressus arizonica).* Maintenance activities within the ROW corridor have discouraged these plant distributions. Their removal is essential for the safe and efficient distribution of electricity along the transmission line corridor.

Species Evaluated

The Navajo Nation Department of Fish and Wildlife (NNDFW) were contacted on July 29, 2011 to provide a list of Threatened, Endangered and Sensitive species that may be impacted by the proposed project. The list included Navajo Endangered Species List (NESL) group 1, 2, and 3 status species and species listed under the Endangered Species Act (ESA) as threatened, endangered or candidate species. The list also included NESL group 4 species. NESL group species are excluded from further evaluation as these species were listed by the NNDFW for awareness and documentation purposes only (Attachment A). These species are not afforded any protection under Navajo or Federal law. If any of these species are seen in the area of this project, the observation will be documented and reported to the NNDFW as requested

Table includes NESL group 1, 2 or 3 status and ESA threatened, endangered, and candidate species. These species have been reported as occurring within the quadrangle maps that the project area crosses. Species are either eliminated from further evaluation or identified as potentially occurring within the project boundaries. Species with the potential to occur within the project boundaries are highlighted in gray and evaluated below.

Table 2. Species from the Endangered Species Act or Navajo Endangered Species List with the potential to occur within the project area.

Common Name	Species Name	Status	Habitat Requirements	Lines	Exclusion Justification
Mammals					
Pronghorn	***Antilocapra americana***	**NESL G3**	**Found in grasslands or desertscrub areas with rolling or dissected hills or small mesas, and usually with scattered shrubs and trees (typically juniper and sagebrush).**	**500-1, 500-2**	**Potentially suitable habitat may be present within the project area, but treatments will not impact foraging abilities or habitat use for this species.**
Black-footed ferret	***Mustela nigripes***	**NESL G2 ESA E**	**Closely associated with prairie dog burrows (non-vegetated, large dirt mounds) in arid plains, desert grassland and desert scrubland from 5,500 to 6,235 feet. Reintroduced in Aubrey Valley, AZ with Gunnison's prairie dog (*Cynomys gunnisoni*)**	**345-1, 500-1**	**Approximately 8.5 miles of the 500-1 line will pass through Aubrey Valley, in the vicinity of the known range of this species.**
Birds					
Golden eagle	***Aquila chrysaetos***	**NESL G3**	**Nest in steep cliffs in sheltered ledges, potholes, or small caves adjacent to foraging habitat of desert grasslands or desertscrub where primary prey of cottontail and jackrabbits are present. Nests on nearly all types of cliff substrates and occur at nearly all elevations across the Navajo Nation.**	**345-1, 500-1, 500-2,**	**Herbicide treatments will be conducted outside the breeding season. The project will not impact the species, its foraging or nesting habitat, or its prey base.**
Burrowing owl	***Athene cunicularia***	**NESL G4**	**Nests in ground burrow typically in dry, open grasslands or desertscrub from 650 to 6,140 feet in elevation, but grasslands with sparse junipers may also be used on the Navajo Nation; presence of suitable nest burrow is critical requisite. Known from broad valleys near Seligman.**	**345-1, 500-1**	**Herbicide treatments will be conducted outside the breeding season. The project will not impact the species, its foraging or nesting habitat, or its prey base.**
Ferruginous hawk	***Buteo regalis***	**NESL G3**	**Nests in badlands, flat or rolling desert grasslands, and desertscrub from 3,500 to 6,000 feet. Most nests on Navajo Nation are on clay or rock pinnacles, small buttes, or short**	**345-1, 500-1, 500-2,**	**Herbicide treatments will be conducted outside the breeding season. The project will not impact the**

Table 2. Species from the Endangered Species Act or Navajo Endangered Species List with the potential to occur within the project area.

Common Name	Species Name	Status	Habitat Requirements	Lines	Exclusion Justification
			cliffs. Hunts in open grasslands that support small mammals for prey.		species, its foraging or nesting habitat, or its prey base.
American dipper	*Cinclus mexicanus*	NESL G3	Nests near swift permanent streams on ledges or crevices of small cliffs, large rocks, fallen logs, and tree roots. Known from the east and west faces of the Chuska Mountains, upper Canyon de Chelly, and the Little Colorado River.	345-1, 500-1, 500-2	Herbicide treatments will be conducted outside the breeding season. The project will not impact the species, its foraging or nesting habitat, or its prey base.
Yellow-billed cuckoo	*Coccyzus americanus*	NESL G2 ESA C	Nests within close proximity to water in mature riparian woodlands of willow, cottonwood, alder, mesquite, hackberry, soapberry, and cultivated fruit trees. Currently known from several sections of the San Juan River. May also occur along the Little Colorado and Colorado rivers, within Canyon de Chelly, Chinle Valley, and other canyons or streams with appropriate habitat.	500-1, 500-2	Herbicide treatments will be conducted outside the breeding season. No suitable habitat is present within the project area.
Southwestern willow flycatcher	*Empidonax traillii extimus*	NESL G2 ESA E	A riparian obligate that prefers dense canopy cover, large volume of foliage, and surface water during midsummer. Nests in willow-cottonwood thickets, tall dense tamarisk, and Russian olive. On the Navajo Nation, breeding is known to occur along the San Juan and Colorado Rivers, but migrant flycatchers have been found in less dense or abundant riparian habitat.	345-1, 500-1, 500-2	Potentially suitable habitat under the 500-2 line at the Little Colorado River and Moenkopi Wash and under the 500-1 line near Cameron at the Little Colorado River may be impacted by herbicide treatments.
Bald eagle	*Haliaeetus leucocephalus*	NESL G2	Nests and winter roosts in large trees in mature and old-growth stands, adjacent to large bodies of water with suitable forage. Nesting sites on various lakes, including: Wheatfields, Tsaile, Many Farms, Morgan, Red and Black Lakes, and various lakes in the Chuska Mountains. Wintering eagles occur along the San Juan and Colorado Rivers.	345-1, 500-1	No adequate foraging, nesting, or perching habitat within project area.

Table 2. Species from the Endangered Species Act or Navajo Endangered Species List with the potential to occur within the project area.

Common Name	Species Name	Status	Habitat Requirements	Lines	Exclusion Justification
Mexican spotted owl	***Strix occidentalis lucida***	**NESL G3 ESA T**	**Mid-aged to mature mixed conifer stands with dense canopies and multiple canopy layers on mountain slopes; steep-walled canyons with riparian vegetation; and sloped drainages with Douglas fir in pinyon-juniper woodland. Known within, or adjacent to, the Chuska Mountains and Defiance Plateau, Canyon de Chelly, Black Mesa and the extensive canyonlands to the north.**	**345-1, 500-1**	**No suitable nesting habitat is present within the project area. The open transmission line corridor may be used for foraging, but prey species and their habitat will be avoided.**
Amphibians					
Northern leopard frog	***Lithobates [Rana] pipiens***	**NESL G2**	**Wetlands with permanent water and aquatic vegetation, ranging from irrigation ditches and small streams to rivers, and small ponds and marshes to lakes or reservoirs. Extirpated from most of its historical range on the Navajo Nation, although potential habitat still exists.**	**500-1, 500-2**	**Herbicides on this project are nontoxic to amphibians and fish. Treatments will avoid aquatic vegetated cover used by this species.**
Fish					
Humpack chub	***Gila cypha***	**NESL G2 ESA E**	**Restricted to the Colorado River and a few of its narrow, canyon-bound tributaries. First-year chubs while adults prefer whitewater with deep, swirling eddies and the turbulent waters near boulders and submerged rocks. Most spawning occurs within the lower 14 kilometers of the Little Colorado River.**	**500-2,**	**Project area is outside known range of this species.**
Roundtail chub	***Gila robusta***	**NESL G2**	**Permanent water in cool to warm mid-elevation streams in pools and eddies, adjacent to rapids and boulders. From the San Juan and Mancos rivers on the Navajo Nation.**	**345-1, 500-1**	**Project area is outside known range of this species.**
Colorado pikeminnow	***Ptchocheilus lucius***	**NESL G2**	**Backwaters and flooded riparian areas during spring runoff; spawn in riffle-run areas with cobble/gravel substrates. Restricted to the Upper Colorado River.**	**500-2**	**Project area is outside known range of this species.**
Razorback sucker	***Xyrauchen texanus***	**NESL G2 ESA E**	**Backwaters over sand and silt substrate, deep eddies, and impoundments. Rare from the San Juan River.**	**500-2**	**Project area is outside known range of this species.**
Invertebrates					

Table 2. Species from the Endangered Species Act or Navajo Endangered Species List with the potential to occur within the project area.

Common Name	Species Name	Status	Habitat Requirements	Lines	Exclusion Justification
Western seep fritillary	***Speyeria nokomis***	**NESL G3**	**Wet meadows, seeps, marshes, and streams with violets (*Viola nephrophylla*). Rare on the Navajo Nation from Chuska Mountains and Defiance Plateau.**	**345-1**	**No suitable habitat is present within the project area.**
Plants					
Gooding's onion	***Allium gooddingii***	**NESL G3**	**Shady, moist canyons and north-facing slopes along streams in mixed conifer and spruce-fir forests. On the Navajo Nation, found between 6,400 to 9,400 feet in elevation in Canyon de Chelly, Chuska Mountains, Apache County, AZ; McKinley and San Juan counties, NM.**	**345-1, 500-1**	**Transmission line corridor is open, providing little to no shade or canopy. No suitable habitat for this species exists, as confirmed during 2004 survey.**
Welsh's milkweed	***Asclepias welshii***	**NESL G3 ESA T**	**Active sand dunes derived from Navajo sandstone in sagebrush, juniper, and ponderosa pine communities. Known populations occur from 5,000 to 6,230 feet elevation.**	**500-2**	**No active sand dunes occur within the transmission line corridor. No suitable habitat is present.**
Mancos milk-vetch	***Astragalus humillimus***	**NESL G2 ESA E**	**Localized populations on large, nearly flat sheets of exfoliating whitish-tan colored standstone, in small depressions and sand filled cracks on or near ledges and mesa tops in slickrock communities of Point Lookout and Cliffhouse Sandstone. Known from the Four Corners area of San Juan County, NM and Montezuma County, CO.**	**345-1, 500-1**	**Potentially suitable soils may be present within the project area on the 345-1 and 500-1 lines east of the Chuska Moutains.**
Naturita milk-vetch	***Astragalus naturitensis***	**NESL G3**	**Sand filled pockets of sandstone slickrock and rimrock pavement along canyons in the pinyon-juniper communities from 5,000 to 7,000 feet in elevation. Known from Hogback, San Juan County to Pineree Canyon, McKinley County, NM.**	**345-1, 500-1**	**Potentially suitable habitat occurs within the project area on the 345-1 line at the Hogback.**
Navajo sedge	***Carex specuicola***	**NESL G3 ESA T**	**Typically found in seeps and hanging gardens, on vertical Navajo sandstone cliffs and alcoves. Known populations occur from 4,600 to 7,200 feet.**	**345-1, 500-1**	**Herbicide treatments will be limited to only areas that can be safely accessed. Potential habitat for this species will be avoided.**
Rhizome (Zuni) fleabane	***Erigeron rhizomatus***	**NESL G2 ESA T**	**Typically only found on fine textured clay hillsides between**	**345-1, 500-1**	**Species not present during 2004**

Table 2. Species from the Endangered Species Act or Navajo Endangered Species List with the potential to occur within the project area.

Common Name	Species Name	Status	Habitat Requirements	Lines	Exclusion Justification
			7,000 and 8,300 feet in elevation. In Arizona, it is known from clays derived from the Chinle Formation in the Zuni and Chuska Mountains.		surveys of potentially suitable habitat.
Round dunebroom	*Errazurizia rotundata*	NESL G3	Known from sandy soils in sandstone, gravelly soils in calcareous outcrops, to deep, alluvial cinders in sandstone breaks in exposed Great Basin Desertscrub. Know from sandy pockets between outcroppings of Moenave Sandstone between Moenave and Willow Springs, Arizona. Populations are known from 4,600 to 5,200 feet elevation.	500-1, 500-2	Potentially suitable habitat may be present within the project area on the 500-2 line at the Gap.
Navajo bladderpod	*Lesquerella navajoensis*	NESL G3	Occurs from 7,200 to 7,600 feet in elevation on windswept mesa rims and nearby habitat with little vegetative cover and high insolation on white Todilto Limestone Member of the Morrison Formation overlaying Entrada Sandstone or Chinle outcrops. Also found at the base and slopes of small hills of the Chinle Formation.	345-1, 345-1, 500-1, 500-1	Potentially suitable habitat may be present within the project area on the 345-1 and 500-1 lines east and west of the Chuska Mountains.
Fickeisen plains cactus	*Pediocactus peeblesianus var. fickeiseniae*	NESL G3 ESA C	Soils overlain by Kaibab Limestone in Navajoan desert or Great Plains grassland, along canyon rims and flat terraces along washes, typically with limestone chips scattered across the surface. Known to occur between 4,000 and 6,000feet elevation. From House Rock Valley and Gray Mt., to the Little Colorado and Colorado rivers, and as far west as Dutchman Draw and Grandstand.	500-1, 500-2	Potentially suitable habitat may be present northwest of Gray Mountain at Needmore and Cedar washes.
Alcove bog-orchid	*Plantanthera zothecina*	NESL G3	Seeps, hanging gardens, and moist stream areas from the desert shrub to pinion-juniper & Ponderosa pine/mixed conifer communities between 4,000 and 7,200 feet in elevation. Requires constant moisture. Known from Oljeto Wash, Tsegi Canyon Watershed, Navajo Mountain,	345-1, 500-1	The Chinle Wash crosses the 500-1 line, however, the habitat is a dry, tamarisk dominated wash. No suitable habitat is present within the project area.

Table 2. Species from the Endangered Species Act or Navajo Endangered Species List with the potential to occur within the project area.

Common Name	Species Name	Status	Habitat Requirements	Lines	Exclusion Justification
			and Chinle Wash drainages.		
Mesa Verde cactus	***Sclerocactus mesae-verdae***	**NESL G2 ESA T**	**Salt-desert scrub communities, typically in the Fruitland and Mancos shale formations, but also in the Menfee Formation overlaying Mancos shale. Frequently found on hilltops or benches and along slopes between 4,900 and 5,500 feet. Known from the CO/NM border near Naschitti, NM.**	**345-1, 500-1**	**Potentially suitable habitat may be present within the project area on the 345-1 east of the Chuska Mountains and at Rock Ridge.**
Alcove death camas	***Zigadenus vaginatus***	**NESL G3**	**Hanging gardens in seeps and alcoves, mostly on Navajo Sandstone between 3, 700 and 6,700 feet in elevation. Known from Navajo Mtn and Canyon de Chelly National Monument.**	**345-1, 500-1**	**Project area is outside known range of this species.**

[NESL – Navajo Endangered Species List, ESA – Endangered Species Act, E – endangered, T – threatened, C - candidate]

Critical Habitat within Activity Area

No critical habitat occurs within the project area.

Conservation Measures

The list of conservation measures to be implemented during the proposed herbicide treatment project will minimize impacts to sensitive wildlife and plants and their habitats:

1. Herbicide treatments will take place outside of the migratory bird breeding season, identified on the Navajo Nation from April 15 through August 15.
2. Quad/ATV access will be restricted to existing roads and within the APS ROW.
3. Quads/ATVs will maintain speeds between 15 to 20 miles per hour while traveling within the APS ROW.
4. Where potentially suitable habitat for sensitive plants exists within the APS ROW, quads/ATVs will remain on existing roads and the treatment sites will be accessed only on foot with workers using backpack and hand held sprayers.
5. In Aubrey Valley, quad/ATV travel will avoid potential black-footed ferret habitat (non-vegetated dirt mounds) within the APS ROW. Quads/ATVs will not drive over or collapse potential black-footed ferret burrows while traveling through the APS ROW or on existing roads.

Species Status and Effects Findings

Black-footed ferret (*Mustela nigripes*)

Endangered Species Act Status:	Endangered
Navajo Status:	NESL Group 2
Critical Habitat:	None designated on Navajo Reservation
Effects Finding:	No Effect

Life History

Black-footed ferrets are small, mink-like mammals that are yellowish brown or buffy above and brownish on the back. This species has a black forehead, black-tipped tail, black feet and legs, and a black mask covering its face. Black-footed ferrets are solitary, nocturnal animals that are active for 2 to 3 hours after sundown and before dawn. Black-footed ferrets are closely associated with prairie dogs, relying on them as a food source and using their burrows to live in and raise young (AGFD 2005a).

Black-footed ferrets were historically known from the Great Plains in Canada to the inter-mountain and southwestern United States. Currently, the only ferrets known on the Navajo Nation are associated with Arizona Game and Fish Department's re-introduced colonies on the Big Boquillas Ranch in Aubrey Valley. Black-footed ferrets are found in medium to large active prairie dog towns. These towns are found in low- to mid-elevations in plains, desert grasslands, and desertscrub communities (Mikesic and Roth 2008). Soils are typically in fine to medium textured silty or sandy clay loams capable of supporting burrows (AGFD 2005a). Prairie dog towns are recognized by clusters of burrows associated with dirt mounds (approximately 60 centimeters [cm] wide by 10 to 20 cm tall [Mikesic and Roth 2008]).

Habitat Evaluation and Suitability

Potentially suitable habitat for this species may exist within the project area where the 500-1 line passes through the Aubrey Valley. The line crosses between 5,440 feet and 5,700 feet in elevation within the Plains and Great Basin Grassland biotic community, supporting flat, open habitats suitable for prairie dogs and black-footed ferrets. The project area in Aubrey Valley is situated on moderately coarse to moderately fine-textured soils of the Torriorthents-Camborthids-Rock Outcrop Association and coarse to moderately fine-textured soils of the Palma-Clovis-Trail Association (Hendricks 1985) suitable for supporting prairie dog and ferret burrows.

Analysis of Effects

Black-footed ferrets and their habitat may be present within the project area during herbicide treatments. However, these treatments will target densely vegetated areas and vegetation (juniper re-sprouts) whose physiology is such that it could potentially impact the reliability of the transmission line. Areas that are densely vegetated are not considered potentially suitable habitat for black-footed ferrets, so herbicide treatments in these areas will not impact black-footed ferrets. Conservation measures have been established to minimize impacts to the black-footed ferret in the open, flat habitats where spot treating re-sprouting vegetation is necessary.

Quad/ATV traffic will avoid all dirt mounds encountered in open, flat habitats within the project area.

Effects Finding
By implementing conservation measures to avoid potential black-footed ferret habitat, the proposed herbicide treatment project will not affect black-footed ferrets or their habitat.

Southwestern willow flycatcher (*Empionax traillii extimus*)

Endangered Species Act Status:	Endangered
Navajo Status:	NESL Group 2
Critical Habitat:	None designated on Navajo Reservation
Effects Finding:	No Effect

Life History
The southwestern willow flycatcher (SWFL) is a medium-sized bird approximately 15 centimeters (cm) long with a brownish-olive to grayish-green upper body and pale olive breast. A white eye ring may be faint or absent, and the bill is usually yellow or pale orange. *E. traillii* and *E. alnorum* are almost identical in appearances but can be distinguished by voice, range, and habitat. The song of *E. traillii* is a distinctive, sneezy "*fitz-bew*". SWFLs lay clutches of 3 to 4 eggs in cup nests from May through July (AGFD 2002).

The breeding range for SWFLs includes Arizona, New Mexico, southwestern Colorado, and southern California, Nevada, and Utah. On the Navajo Nation, breeding is known to occur along the San Juan and Colorado Rivers. Potentially suitable habitat for migrant flycatchers can be found across the Navajo Nation. SWFLs are found nesting in dense riparian vegetation (mixed native [eg. *Salix* spp.] and/or exotic [eg. Russian olive, saltcedar] species, with or without an over-story) near surface water or saturated soils. Migrant flycatchers may use riparian habitats unsuitable for breeding and in non-riparian areas (Mikesic and Roth 2008).

Habitat Evaluation and Suitability
The project area does not occur within known or suitable nesting habitat for the SWFL. Potentially suitable habitat for migrants may exist within the project area under the 500-1 and 500-2 lines near Cameron at the Little Colorado River, and under the 500-2 line at Moenkopi Wash. Each location consists of a sandy wash or riverbed vegetated with young tamarisk trees, less than 10 feet tall. The tamarisk is patchy and scattered on the 500-2 line at the Little Colorado River and at Moenkopi Wash. A small patch (less than 250 feet wide) under the 500-1 line at the Little Colorado River is densely vegetated with tamarisk trees. All sites lack the vegetative structure and saturated soils required to be considered breeding habitat. The sites may be suitable for migrant flycatchers.

Analysis of Effects
The sites under the 500-1 and 500-2 lines at the Little Colorado River and under the 500-2 line at Moenkopi Wash may be suitable for migrant flycatchers. However, herbicide treatments will take place outside of the SWFL's breeding season (May through August), so no breeding or migrant flycatcher will be impacted. Herbicide treatments are necessary under the lines at these

locations, so potentially suitable habitat for migrant flycatchers will be impacted. However, similar habitat is available up and downstream of the transmission lines at all 3 locations, and the loss of potentially suitable habitat for migrant flycatchers (12.1 acres) will be negligible.

Effects Finding
By implementing conservation measures to avoid potential SWFL habitat, the proposed herbicide treatment project will not affect SWFL or their habitat.

Mancos milkvetch (*Astragalus humillimus*)

Endangered Species Act Status:	Endangered
Navajo Status:	NESL Group 2
Critical Habitat:	None designated on Navajo Reservation
Effects Finding:	No Effect

Life History
Mancos milkvetch is a small, mat forming perennial plant of the Fabaceae (Pea Family). Stems reach up to 1 cm in length and leaves reach up to 4 cm long. Leaf stalks are covered in persistent spines. Flowers appear between mid April to early May and are lavender to purplish with a conspicuous lighter colored spot on the throat of the corolla tube (Mikesic and Roth 2008).

Mancos milkvetch is known from the Four Corners area of San Juan County, New Mexico and Montezuma County, Colorado. On the Navajo Nation, this plant is known from east of the Hogback and south of the San Juan River to a hogback east of Little Water. This species is found on large, nearly flat sheets of exfoliating whitish-tan colored sandstone, in small depressions and sand filled cracks on or near ledges and mesa tops in slickrock communities of Point Lookout and Cliffhouse Sandstone formations (Mikesic and Roth 2008) between 5,000 and 6,000 feet in elevation (NMRPC 1999).

Habitat Evaluation and Suitability
Potentially suitable habitat for Mancos milkvetch may exist within the project area under the 345-1 and 500-1 lines east of Chuska Mountains near and along the Hogback (**Error! Reference source not found.**). The soils under the lines at the locations described in **Error! Reference source not found.** are derived from Point Lookout and Cliffhouse Sandstones and fall between 5,400 and 5,800 feet in elevation. The sandstone outcrops on ledges and ridges in these locations are suitable substrates for Mancos milkvetch.

Analysis of Effects
Mancos milkvetch will be avoided during herbicide treatments because it is not a target species and will not be confused with target species (pine, juniper, oak, and saltcedar). The critical time for potential impacts to this species is between April 1 and May 31 when plants are emerging, flowers, and dispersing seed. This is outside the project's timeframe. Through the implementation of conservation measures (limiting quad/ATV traffic to existing roads and limiting access to foot traffic within sensitive plant habitats), this species will not be impacted.

Effects Finding
By implementing conservation measures discussed above, the proposed herbicide treatment project will not affect Mancos milkvetch.

Naturita milkvetch (*Astragalus naturitensis*)

Endangered Species Act Status:	None
Navajo Status:	NESL Group 3
Critical Habitat:	None designated on Navajo Reservation
Effects Finding:	No Effect

Life History
Naturita milkvetch is a low perennial plant of the Fabaceae (Pea Family). Stems are subterranean and 2 to 6 cm long. Leaves are up to 6 cm long, with 9 to 15 leaflets covered with straight, overlapping hairs. Flowers appear between late April to May and are bi-colored with a banner of white and lilac and purple wings and keel-tips (Mikesic and Roth 2008).

Naturita milkvetch is known from San Juan County and McKinley counties, New Mexico, southwestern Colorado, and adjacent Utah. On the Navajo Nation, this plant is known from the Hogback to Pinetree Canyon. This species is found in sand filled pockets of sandstone slickrock and ricmrock pavement along canyons in pinyon-juniper communities between 5,000 and 7,000 feet in elevation (Mikesic and Roth 2008).

Habitat Evaluation and Suitability
Potentially suitable habitat for naturita milkvetch may exist under the 500-1 transmission line on the sandstone slickrock and rimrock along the Hogback at approximately 5,500 feet in elevation (see Appendix B: Habitat Locations for Sensitive Plants within the Project Area).

Analysis of Effects
Suitable habitat for naturita milkvetch occurs within the project area along the 500-1 line. However, during a helicopter flyover assessment, it was determined that no herbicide treatments are necessary within the APS ROW at this site. With the implementation of conservation measures (limiting quad/ATV traffic to existing roads), this species will not be impacted.

Effects Finding
The proposed herbicide treatment project will not affect naturita milkvetch.

Rhizome (Zuni) fleabane (*Erigeron rhizomatus*)

Endangered Species Act Status:	Threatened
Navajo Status:	NESL Group 2
Critical Habitat:	None designated on Navajo Reservation
Effects Finding:	No Effect

Life History

Rhizome fleabane is an herbaceous perennial of the Asteraceae (Sunflower Family). Tall, sparsely branching stems arise from subterranean rhizomes. Leaves are alternate, typically hairless, and oblong and found more densely on sterile stems than on flowering stems (USFWS 1988). Flower heads are solitary with 25 to 40 white or tinged blue-violet ray flowers and yellow disk flowers appearing from late May through June (Mikesic and Roth 2008).

Rhizome fleabane is known from McKinley, San Juan, and Catron counties, New Mexico, and Apache County, Arizona. On the Navajo Nation, this plant is known from the slopes of the Chuska Mountains from Lukachukai and west of Red Valley south to Navajo (Mikesic and Roth 2008). This species is typically found on fine textured clay hillsides derived from the Chinle Formation or similar clay soils of the Baca Formation (Mikesic and Roth 2008), often on steep, easily erodible soil that does not crust over (USFWS 1988). Rhizome fleabane is found in sparsely-vegetative pinyon-juniper communities on north-, east-, and west-facing slopes between 7,000 feet and 8,300 feet in elevation (Mikesic and Roth 2008; USFWS 1988).

Survey History

Potentially suitable habitat for rhizome fleabane was surveyed on August 14 and August 15, 2004 by Tracy Moore, APS Natural Resource Specialist. Of the 7 sites identified on the 345-1 line, five were found to be outside of the suitable elevation range and lacking suitable soil conditions. Based on field surveys and topographic evaluation, it was determined that the remaining 2 sites did not provide suitable habitat for rhizome fleabane. The 2004 evaluation excluded suitable habitat for rhizome fleabane from the 345-1 transmission line corridor.

Habitat Evaluation and Suitability

Potentially suitable habitat for this species exists within the project area where the 500-1 line crosses the Chuska Mountains along the Arizona-New Mexico border (see Appendix B: Habitat Locations for Sensitive Plants within the Project Area). The habitat under the lines is classified as Petran Montane Conifer Forest biotic community between 7,200 feet and 7,600 feet in elevation. Soils under the line consist of moderately coarse to moderately fine-textured soils formed in alluvium weathered from sandstone and shale (Hendricks 1985) and are derived from the Chinle Formation. Finely textured soils of the Chinle Formation have been documented to support Rhizome fleabane (USFWS 1988).

Analysis of Effects

Rhizome fleabane will be avoided during herbicide treatments because it is not a target species (pine, juniper, oak, and saltcedar). The critical time for potential impacts to this species is between May 1 and June 31 when plants are emerging, flowers, and dispersing seed. This is outside the project's timeframe. Through the implementation of conservation measures (limiting quad/ATV traffic to existing roads and limiting access to foot traffic within sensitive plant habitats), this species will not be impacted.

Effects Finding

The proposed herbicide treatment project will not affect rhizome fleabane.

Round dune-broom (*Errazurizia rotundata*)

Endangered Species Act Status:	None
Navajo Status:	NESL Group 4
Critical Habitat:	None designated on Navajo Reservation
Effects Finding:	No Effect

Life History

Round dune-broom is a low, woody shrub of the Fabaceae (Pea Family) reaching up to 14 inches tall. The leaves and stems are covered in short, stiff bristle hairs with many orange or purple, prickle shaped glands. Leaves are 1.18-5 inches long with a recurving rachis and 29 to 61 oblong leaflets. Flowers are about 5 millimeters long with only a pale yellow banner and no keels or wings, appearing from late April to late May (Mikesic and Roth 2008).

Round dune-broom is known from the vicinity of Tuba City, Winslow, Holbrook, and Wupatki National Monument, Arizona. On the Navajo Nation, it is distributed between Moenave and Willow Springs in Coconino County, Arizona. Round dune-broom is known from outcrops ranging from sandy soils in sandstone, gravelly soils in calcareous outcrops, to deep, alluvial cinders in sandstone breaks. On the Navajo Nation it is known from sandy pockets between outcroppings of Moenave Sandstone. It is generally found in exposed Great Basin desertscrub communities with widely spaced shrubs between 4,600 feet and 5,200 feet in elevation (Mikesic and Roth 2008).

Habitat Evaluation and Suitability

Potentially suitable habitat for round dune-broom may occur under the 500-2 line near The Gap, AZ (see Appendix B: Habitat Locations for Sensitive Plants within the Project Area). This portion of the project area falls within Great Basin Desertscrub at approximately 5,300 feet in elevation. Soils under the 500-1 line are derived from the Moenave Sandstone Formation. The vegetative community appears sparse, and soils support round dune-brome.

Analysis of Effects

Round dune-broom will be avoided during herbicide treatments because it is not a target species (pine, juniper, oak, and saltcedar). The critical time for potential impacts to round dune-broom is between April 15 and May 31 when plants are emerging, flowering, and dispersing seed. This time period is outside the project's timeframe. Through the implementation of conservation measures (limiting quad/ATV traffic to existing roads and limiting access to foot traffic within sensitive plant habitats), this species will not be impacted.

Effects Finding

The proposed herbicide treatment project with implementation of the proposed conservation measures would not affect round dune-broom.

Navajo bladderpod (*Lesquerella navajoensis*)

Endangered Species Act Status:	None
Navajo Status:	NESL Group 3
Critical Habitat:	None designated on Navajo Reservation
Effects Finding:	No Effect

Life History

Navajo bladderpod is an herbaceous perennial of the Brassicaceae (Mustard Family) originating from a thick taproot. The leaves and stems are silvery-gray with densely covered with overlapping, bristlelike hairs radiating out in a star shaped pattern. Linear leaves taper off at the base of the plant. Flowers and fruits are densely arranged at the peak of the flowering stems, but barely extend beyond the leaves (AGFD 2005b). Flowers petals are deep yellow and appear from mid April to mid June (Mikesic and Roth 2008).

Navajo bladderpod is known from McKinley County, New Mexico, Apache County, Arizona, and Kane County, Utah (AGFD 2005b). On the Navajo Nation it is known from mesa rims northwest of Thoreau and Continental Divide, and Chuska Mountains, at Todilto Park, and the Red Valley area to Wheatfields Lake (Mikesic and Roth 2008). Navajo bladderpod mostly occurs on windward, windswept, sparse pinyon-juniper woodlands on mesa rims and nearby habitat that is highly exposed to solar radiation from 7,200 to 7,600 feet in elevation. It is typically found on the Todilto Limestone Member of the Morrison Formation overlaying Entrada Sandstone or Chinle outcrops (AGFD 2005b). It can also be found at the base of slopes and small hills of the Chinle Formation (Mikesic and Roth 2008).

Habitat Evaluation and Suitability

Potentially suitable habitat for Navajo bladderpod exists where the 345-1 and 500-1 lines cross sparsely vegetated pinyon-juniper woodlands east and west of the Chuska Mountains (see Appendix B: Habitat Locations for Sensitive Plants within the Project Area). Soils under the 345-1 and 500-1 lines are of the Chinle and Morrison formations. A helicopter flyover assessment located ridges and ledges that would support potentially suitable for this species.

Analysis of Effects

Navajo bladderpod will be avoided during herbicide treatments because it is not a target species (pine, juniper, oak, and saltcedar). The critical time for potential impacts to this species is between May 1 and June 31 when plants are emerging, flowering, and dispersing seed. This time period is outside the project's timeframe. Through the implementation of conservation measures (limiting quad/ATV traffic to existing roads and limiting access to foot traffic within sensitive plant habitats), this species will not impacted.

Effects Finding

The proposed herbicide treatment project with implementation of the proposed conservation measures would not affect Navajo bladderpod.

Fickeisen pincushion cactus (*Pediocactus peeblesianus var. fickeiseniae*)

Endangered Species Act Status:	Candidate
Navajo Status:	NESL Group 3
Critical Habitat:	None designated on Navajo Reservation
Effects Finding:	No Effect

Life History

Fickeisen pincushion cactus is a small, globose, perennial succulent that reaches 2.4 inches tall and 2.2 inches in diameter. The areoles are circular with corky or spongy, white to pale gray spines. The central spines are 0.2 to 0.3 inches long and ascending while the radial spines number from three to seven, reach 0.1 to 0.4 inches long and recurve. Cream, yellow, or yellowish-green flowers appear in late April and produce fruits from May to June. During periods of drought, this species retracts into the soil (USFWS 2001, AGFD 2004).

Fickeisen pincushion cactus is known from Coconino, Mohave, and Navajo counties in Arizona. Locations in Coconino County are scattered from House Rock Valley and near Gray Mountain and along the canyons of the Little Colorado and Colorado rivers. Locations in Mohave County have been found in Hurricane and Main Street Valleys, and near Clayhole and Sunshine ridges (AGFD 2004).

Fickeisen pincushion cactus occurs from 4,000 to 5,940 feet on flat ridge-tops and benches, well-drained hills, and canyon margins within Great Basin Desert Scrub, Great Basin Grassland, and Plains Grassland communities (AGFD 2004). This species is found on shallow, gravelly limestone loam or limestone chips derived from Kaibab Limestone (AGFD 2004, Mikesic and Roth 2008).

Habitat Evaluation and Suitability

Potentially suitable habitat for Fickeisen pincushion cactus exists within the project area under the 500-2 line northwest of Gray Mountain between 4,900 and 5,100 feet in elevation (see Appendix B: Habitat Locations for Sensitive Plants within the Project Area). Soils in this area are limestone chips and sandstone outcrops derived from the Kaibab Limestone Formation. Soils are suitable to support habitat for Fickeisen pincushion cactus.

Analysis of Effects

Fickeisen pincushion cactus will be avoided during herbicide treatments because it is not a target species (pine, juniper, oak, and saltcedar). The critical time for potential impacts Fickeisen pincushion cactus is between May 15 and April 31 when plants are flowering and dispersing seed. This time period is outside the project's timeframe. Fickeisen pincushion cactus is a cryptic, small cactus that is difficult to identify when it is not flowering, and retracts into the soil during periods of drought, but through the implementation of conservation measures (limiting quad/ATV traffic to existing roads and limiting access to foot traffic within sensitive plant habitats), this species will not be impacted.

Effects Finding
The proposed herbicide treatment project with implementation of the proposed conservation measures would not affect Fickeisen pincushion cactus.

Mesa Verde cactus (*Sclerocactus mesae-verdae*)

Endangered Species Act Status:	Threatened
Navajo Status:	NESL Group 2
Critical Habitat:	None designated on Navajo Reservation
Effects Finding:	No Effect

Life History
Mesa Verde cactus is a small, cryptic succulent from the Cactus (Cactaceae) family. It may be found in clusters, but is often a solitary plant growing 3 to 11 cm long and up to 10 cm in diameter. This species has 13 to 17 ribs and 7 to 13 straw-colored radial spines reaching 6 to 13 cm long. The flowers are yellowish-cream to pinkish flowering between April and early May (Mikesic and Roth 2008).

Mesa Verde cactus is known from San Juan County, New Mexico and Montezuma County, Colorado. On the Navajo Nation, this species is known from the Colorado border south to Naschitti, New Mexico. Mesa Verde cactus occurs in salt-desert scrub communities on soils derived from Fruitland and Mancos shale formations, but also from the Menefee Formation overlaying Mancos shale. It is found on the tops of hills or benches and along slopes between 4,900 and 5,500 feet in elevation (Mikesic and Roth 2008).

Habitat Evaluation and Suitability
Potentially suitable habitat for Mesa Verde cactus exists within the project area under the 500-1 line at Bennett Peak and Rock Ridge, west of the Chuska Mountains (see Appendix B: Habitat Locations for Sensitive Plants within the Project Area). Vegetation under the line is consistent with desertscrub communities falls between 5,400 feet and 6,100 feet in elevation. Soils are derived from the Menefee, Fruitland, and Mancos shale formations.

Analysis of Effects
Mesa Verde cactus will be avoided during herbicide treatments because it is not a target species (pine, juniper, oak, and saltcedar). The critical time for potential impacts to Mesa Verde cactus is between April 1 and May 31 when plants are flowering and dispersing seed. This time period is outside the project's timeframe. Mesa Verde cactus is a cryptic, small cactus that is difficult to identify when it is not flowering, but through the implementation of conservation measures (limiting quad/ATV traffic to existing roads and limiting access to foot traffic within sensitive plant habitats), this species will not be impacted.

Effects Finding
The proposed herbicide treatment project with implementation of the proposed conservation measures would not affect Mesa Verde cactus.

References:

Arizona Game and Fish Department. 1999. *Allium goodingii*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, Arizona.

_____. 2001. *Athene cunicularia hypugaea*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, Arizona.

_____. 2002. *Empidonax traillii extimus*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, Arizona.

_____. 2003. *Buteo regalis*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, Arizona.

_____. 2004. *Platanthera zothecina*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, Arizona.

_____. 2005a. *Mustela nigripes*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, Arizona.

_____. 2005b. *Lesquerella navajoensis*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, Arizona.

Arizona Rare Plant Committee. 2001. Arizona rare plant field guide: a collaboration of agencies and organizations. Washington: U.S. Government Printing Office.

Brown, David E., ed. 1994. Biotic Communities: Southwestern United States and Northwestern Mexico, University of Utah Press

Ganey, J. L. 1998. "Spotted Owl" in *The Raptors of Arizona* (edited by R. L. Glinski). 170–174. Arizona Game and Fish Department, Phoenix.

Glinski, R. L. 1998. "Ferruginous hawk" in *The Raptors of Arizona* (edited by R. L. Glinski). 105–108. Arizona Game and Fish Department, Phoenix.

Hunt, W. G. 1998. "Bald Eagle" in *The Raptors of Arizona* (edited by R. L. Glinski). 50–54. Arizona Game and Fish Department, Phoenix.

Mikesic, D.G., and D. Roth. 2008. Navajo Nation Endangered Species List Species Accounts (version 3.08). Navajo Natural Heritage Program, Department of Fish & Wildlife. Window Rock, AZ

New Mexico Rare Plant Council (NMRPC). 1999. New Mexico Rare Plants. Albuquerque, NM: New Mexico Rare Plants Home Page. <http://nmrareplants.unm.edu> (Latest update: 11 July 2011).

U.S. Fish and Wildlife Service. 1988. Zuni Fleabane (*Erigeron rhizomatus*) recovery plan. US Fish and Wildlife Service, New Mexico Field Office, Albuquerque, New Mexico.

_____. 1995. Recovery plan for the Mexican spotted owl (*Strix occidentalis lucida*). U.S. Department of the Interior, Fish and Wildlife Service. Albuquerque, New Mexico.

_____. 1998. General Biology and Ecological Relationships of the Mexican Spotted Owl. Official website of the USFWS Mexican Spotted Owl Recovery Program. http://mso.fws.gov. 3 pp.

_____. 2001. Goodding's Onion (*Allium gooddingii*) General Species Information. Arizona Ecological Services, Phoenix, Arizona.

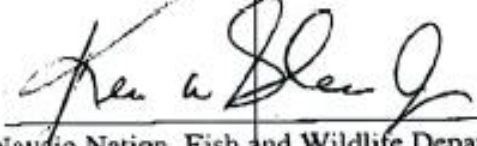
———. 2004. "Endangered and Threatened Wildlife and Plants; Final Designation of Critical Habitat for the Mexican spotted owl; Final Rule". Federal Register 69(168): 53182–53298.

Signatures:

Prepared By:

Jennifer Cleland, Contracted Services, APS Forestry and Special Programs — August 26, 2011 (Date)

Approved By:



Navajo Nation, Fish and Wildlife Department — 9/16/11 (Date)

Coordination:

*Tracy Moore, Arizona Public Service Company, Forestry and Special Programs
*Pamela Kyselka, Navajo Nation, Fish and Wildlife Department
*Andrea Hazelton, Navajo Nation, Fish and Wildlife Department
*Chad Smith, Navajo Nation, Fish and Wildlife Department

Appendix A: Navajo Fish and Wildlife G4 Species

The table below lists the Navajo Endangered Species Listed (NESL) G4 that were excluded from this evaluation. These species are not afforded any protection under Navajo or Federal law, and were provided by Navajo Fish and Wildlife Department (NFWD) for documentation and awareness purposes only. If any of these species are seen in the area of this project, the observation will be documented and reported to the NFWD as requested

Species listed by the Navajo Fish and Wildlife Department for documentation purposes.

Common Name	Species Name	Navajo / Federal Status
Mammals		
Banner-tailed kangaroo rat	***Dipodomys spectabilis***	**NESL G4**
Wupatki pocket mouse	***Perognathus amplus cineris***	**NESL G4**
Kit fox	***Vulpes macrotis***	**NESL G4**
Birds		
Northern goshawk	***Accipiter gentilis***	**NESL G4**
Northern saw-whet owl	***Aegolius acadicus***	**NESL G4**
Burrowing owl	***Athene cunicularia***	**NESL G4**
Mountain plover	***Charadrius montanus***	**NESL G4**
Blue grouse	***Dendragapus obscures***	**NESL G4**
Yellow warbler	***Dendroica petechia***	**NESL G4**
Hammond's flycatcher	***Empidonax hammondii***	**NESL G4**
Peregrine falcon	***Falco peregrinus***	**NESL G4**
Northern pygmy-owl	***Glaucidium gnoma***	**NESL G4**
California condor	***Gymnopyps californianus***	**NESL G4**
Flammulated owl	***Otus flammeolus***	**NESL G4**
Band-tailed pigeon	***Patagioenasa fasciata***	**NESL G4**
Three-toed woodpecker	***Picoides dorsalis***	**NESL G4**
Sora	***Porzana carolina***	**NESL G4**
Tree swallow	***Tachycineta bicolor***	**NESL G4**
Reptiles		
Milk snake	***Lampropeltis triangulum***	**NESL G4**
Fish		
Bluehead sucker	***Catostomus discobolus***	**NESL G4**
Mottled sculpin	***Cottus bairdi***	**NESL G4**
Invertebrates		
Rocky mountainsnail	***Oreohelix strigosa***	**NESL G4**
Plants		
Peebles' blue-star	***Amsonia peeblesii***	**NESL G4**
San Juan milkweed	***Asclepias sanjuanensis***	**NESL G4**
Beath milk-vetch	***Astragalus beathii***	**NESL G4**
Atwood's camissonia	***Camissonia atwoodii***	**NESL G4**
Rydberg's thistle	***Cirsium rydbergii***	**NESL G4**
Yellow lady's slipper	***Cypripedium parviflorum var. pubescens***	**NESL G4**
Sarah's buckwheat	***Eriogonum lachnogynum var. sarahiae***	**NESL G4**
Sivinski's fleabane	***Erigeron sivinskii***	**NESL G4**
Cave primrose	***Primula specuicola***	**NESL G4**
Parish's alkali grass	***Puccinellia parishii***	**NESL G4**
Arizona rose sage	***Salvia pachyphylla spp. Eremopictus***	**NESL G4**

Appendix B: Habitat Locations for Sensitive Plants within the Project Area

Habitats locations for sensitive plants under the 345-1, 500-1, and 500-2 transmission lines.

Species	Feature	Northing_Y	Easting_X	Line	Span	Existing road access?	Conservation Measures?
Mancos milkvetch	wash	2323400.04615	13247132.87790	345-1	19/3 – 20/1	Yes	Yes
Mancos milkvetch	wash	2323296.77240	13246991.40700	345-1	19/3 – 20/1	Yes	Yes
Mancos milkvetch	wash	2323143.98383	13246968.77170	345-1	19/3 – 20/1	Yes	Yes
Mancos milkvetch	no treatment	2303421.18354	13216938.05750	345-1	26/2 – 26/3	no treatment	No
Navajo bladderpod	ridge	2141030.99733	13019828.79510	345-1	75/1 – 75/2	Yes	Yes
Navajo bladderpod	slope	2106822.96644	12981527.89250	345-1	84/3 – 85/1	Yes	Yes
Navajo bladderpod	slope	2106957.70465	12981678.52300	345-1	84/3 – 85/1	Yes	Yes
Navajo bladderpod	ridge	2106096.40394	12980675.02790	345-1	85/1 – 85/2	Yes	Yes
Mancos milkvetch	no treatment	2341931.67543	13312930.54720	500-1	9/1 – 9/2	no treatment	No
Mancos milkvetch	ridge	2263547.32273	13285511.77430	500-1	24/3 – 24/4	Yes	Yes
Mancos milkvetch	ridge	2262939.81974	13285299.04270	500-1	24/4 – 25/1	Yes; walk to ridge	Yes
Mancos milkvetch	ridge	2262003.99761	13284974.77610	500-1	25/1 – 25/2	No; not nearby	Yes
Mancos milkvetch	no treatment	2243463.65220	13278485.41440	500-1	28/3 – 29/1	no treatment	No
Mesa Verde cactus	slope	2265231.96147	13286093.44910	500-1	24/2 – 24/3	Yes; walk to wash	Yes
Mesa Verde cactus	ridge	2263727.24757	13285570.92760	500-1	24/3 – 24/4	Yes	Yes
Mesa Verde cactus	no treatment	2242260.52720	13278068.74770	500-1	29/1 – 29/2	no treatment	No
Naturita milkvetch	no treatment	2361321.69451	13318678.50000	500-1	4/3 – 5/1	no treatment	No
Naturita milkvetch	no treatment	2361850.31720	13318713.56790	500-1	5/1 – 5/2	no treatment	No
Navajo bladderpod	ridge	2212217.90505	13267563.74800	500-1	35/1 – 35/2	Yes	Yes
Navajo bladderpod	slope	2149229.79663	13228984.34340	500-1	49/2 – 49/3	Yes	Yes
Navajo bladderpod	slope	2147922.70620	13228165.38660	500-1	49/3 – 49/4	Yes	Yes
Navajo bladderpod	slope	2148151.37317	13228308.67990	500-1	49/3 – 49/4	Yes	Yes
Navajo bladderpod	slope	2145803.56118	13226837.75090	500-1	49/4 – 50/1	Yes	Yes
Navajo bladderpod	slope	2131227.72002	13217710.23230	500-1	53/2 – 53/3	No; not nearby	Yes
Navajo bladderpod	outcrop	2130533.49133	13217276.04860	500-1	53/2 – 53/3	No; not nearby	Yes
Navajo bladderpod	outcrop	2130166.05645	13217046.09170	500-1	53/3 – 54/1	No; not nearby	Yes
Navajo bladderpod	ridge	2129428.00689	13216583.76460	500-1	53/3 – 54/1	No; not on ridge	Yes
Navajo bladderpod	base	2129659.36855	13216731.34860	500-1	53/3 – 54/1	No; not on ridge	Yes
Navajo bladderpod	outcrop	2129393.89231	13216561.62920	500-1	53/3 – 54/1	No; not nearby	Yes

Habitats locations for sensitive plants under the 345-1, 500-1, and 500-2 transmission lines.

Species	Feature	Northing_Y	Easting_X	Line	Span	Existing road access?	Conservation Measures?
Navajo bladderpod	outcrop	2129117.33872	13216389.48930	500-1	54/1 – 54/2	No; not nearby	Yes
Navajo bladderpod	outcrop	2128839.48545	13216215.64510	500-1	54/1 – 54/2	No; not nearby	Yes
Navajo bladderpod	slope	2128524.51510	13216018.57800	500-1	54/1 – 54/2	No; not nearby	Yes
Navajo bladderpod	outcrop	2127867.72211	13215607.64300	500-1	54/1 – 54/2	No; not nearby	Yes
Navajo bladderpod	outcrop	2127118.17003	13215138.34460	500-1	54/2 – 54/3	No; not nearby	Yes
Navajo bladderpod	outcrop	2126861.31016	13214977.37340	500-1	54/2 – 54/3	No; not nearby	Yes
Navajo bladderpod	outcrop	2122369.51941	13212164.16670	500-1	55/2 – 55/3	No; not nearby	Yes
Rhizome fleabane	base	2190192.26013	13255660.54940	500-1	39/5 – 40/1	Yes	Yes
Rhizome fleabane	base	2189480.72843	13254750.24060	500-1	40/1 – 40/2	Yes	Yes
Rhizome fleabane	slope	2188032.81790	13253006.42330	500-1	40/1 – 40/2	Yes	Yes
Rhizome fleabane	slope	2187537.52115	13252388.16790	500-1	40/2 – 40/3	Yes	Yes
Rhizome fleabane	slope	2187711.86325	13252614.04510	500-1	40/2 – 40/3	Yes	Yes
Rhizome fleabane	slope	2187870.85448	13252810.31700	500-1	40/2 – 40/3	Yes	Yes
Rhizome fleabane	slope	2188191.02992	13253214.92230	500-1	40/2 – 40/3	Yes	Yes
Rhizome fleabane	slope	2186966.64977	13251621.76000	500-1	40/3 – 40/4	Yes	Yes
Round dune-broom	slope	1508935.38305	13177718.76860	500-2	42/2 – 42/3	Yes	Yes
Round dune-broom	slope	1509006.09367	13177441.58290	500-2	42/2 – 42/3	Yes	Yes
Round dune-broom	wash	1509606.63565	13180381.06790	500-2	43/1 – 43/2	Yes	Yes
Round dune-broom	wash	1509735.10787	13180360.23460	500-2	43/1 – 43/2	Yes	Yes
Fickeisen pincushion	wash	1484036.28663	12987255.73790	500-2	83/1 – 83/2	Yes	Yes
Fickeisen pincushion	wash	1484117.01580	12987149.83510	500-2	83/2 – 83/3	Yes	Yes
Fickeisen pincushion	wash	1486614.43917	12988717.38220	500-2	82/2 – 82/3	Yes	Yes
Fickeisen pincushion	wash	1486705.59222	12988602.85660	500-2	82/3 – 83/1	Yes	Yes
Fickeisen pincushion	outcrop	1477818.64135	12983721.68430	500-2	84/2 – 84/3	Yes	Yes

UTMs given in NAD 83

Appendix C: Habitat Location Maps for Sensitive Plants

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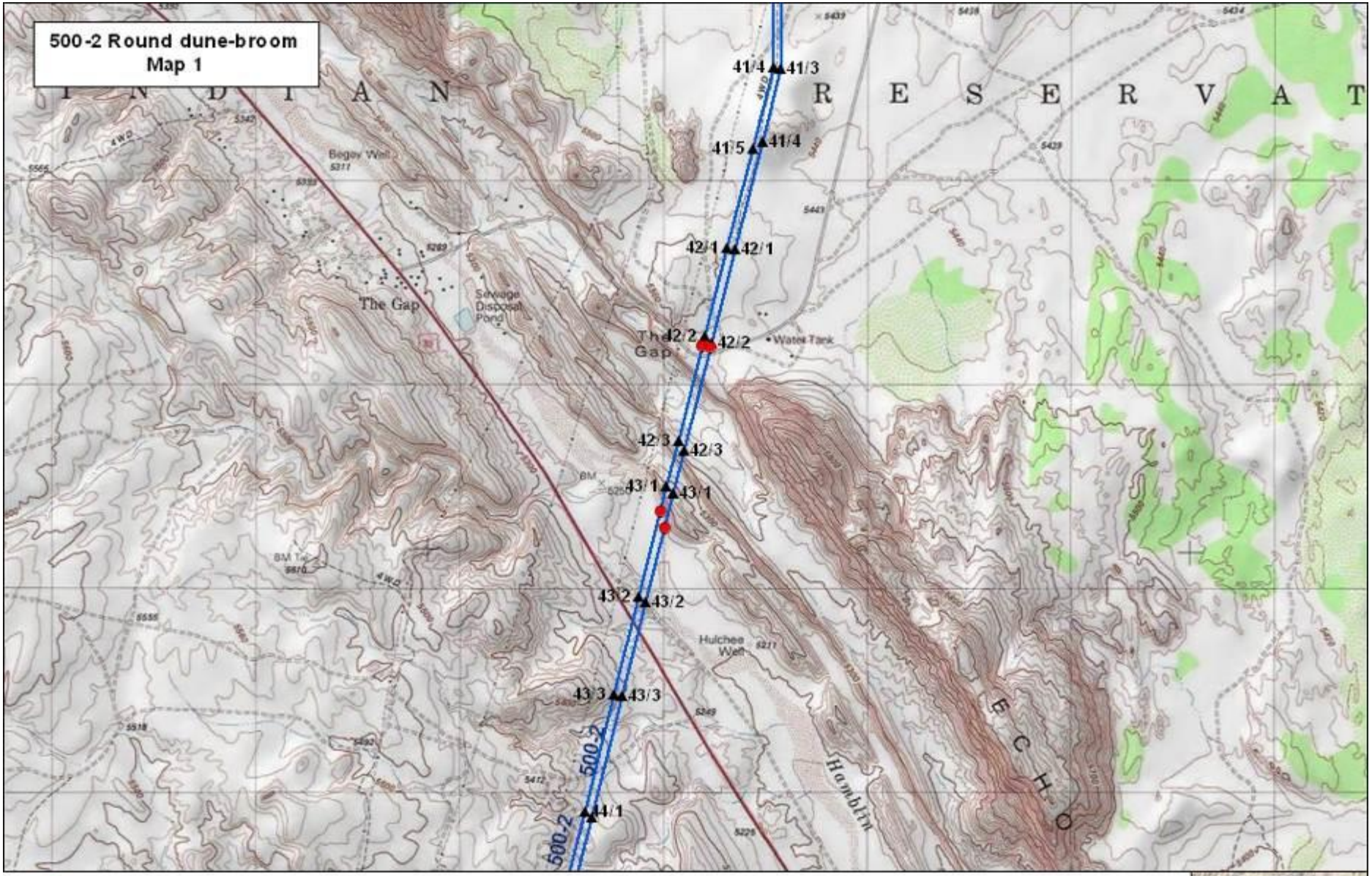

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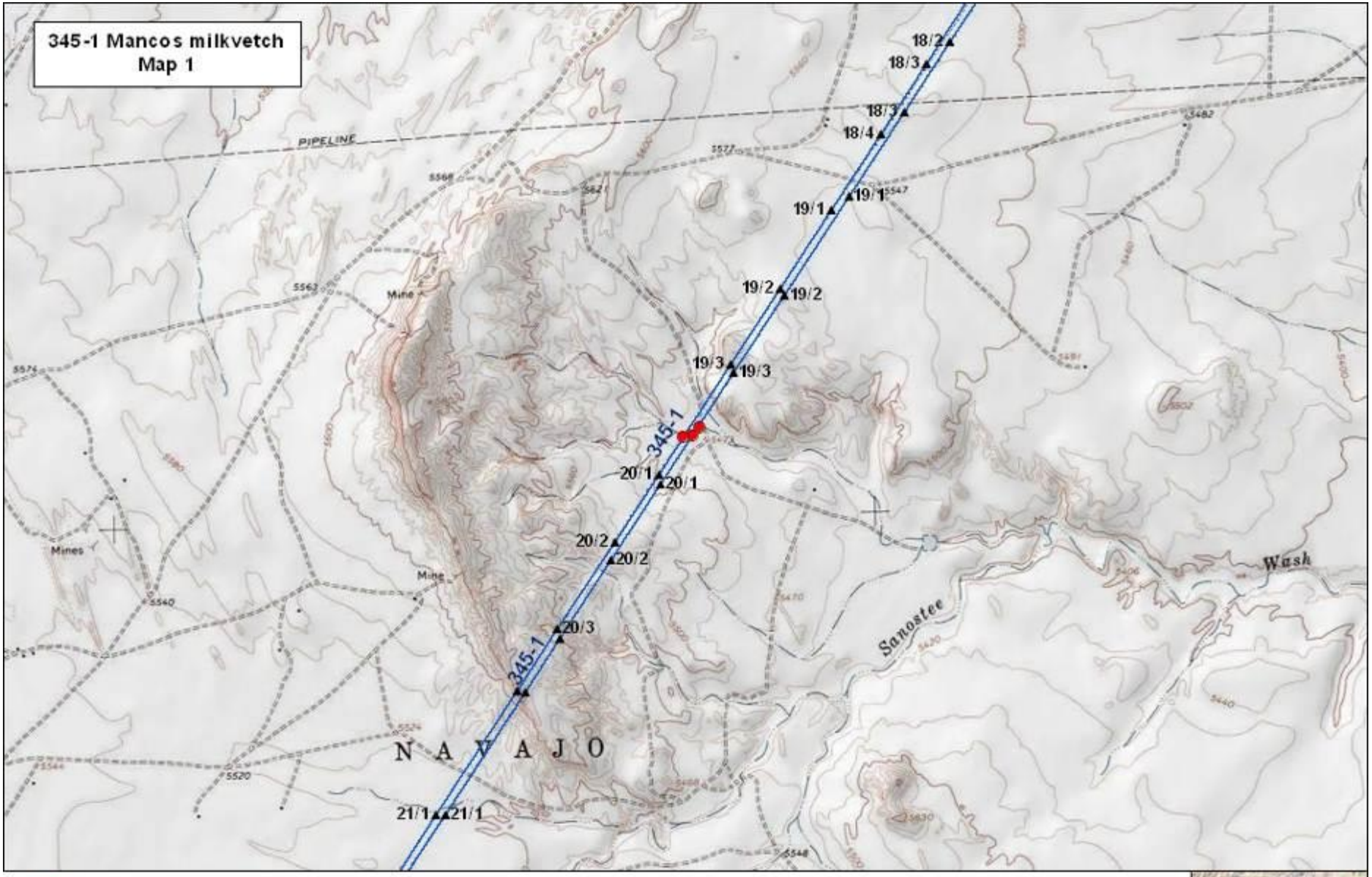

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Potential Habitat Locations

Project Area

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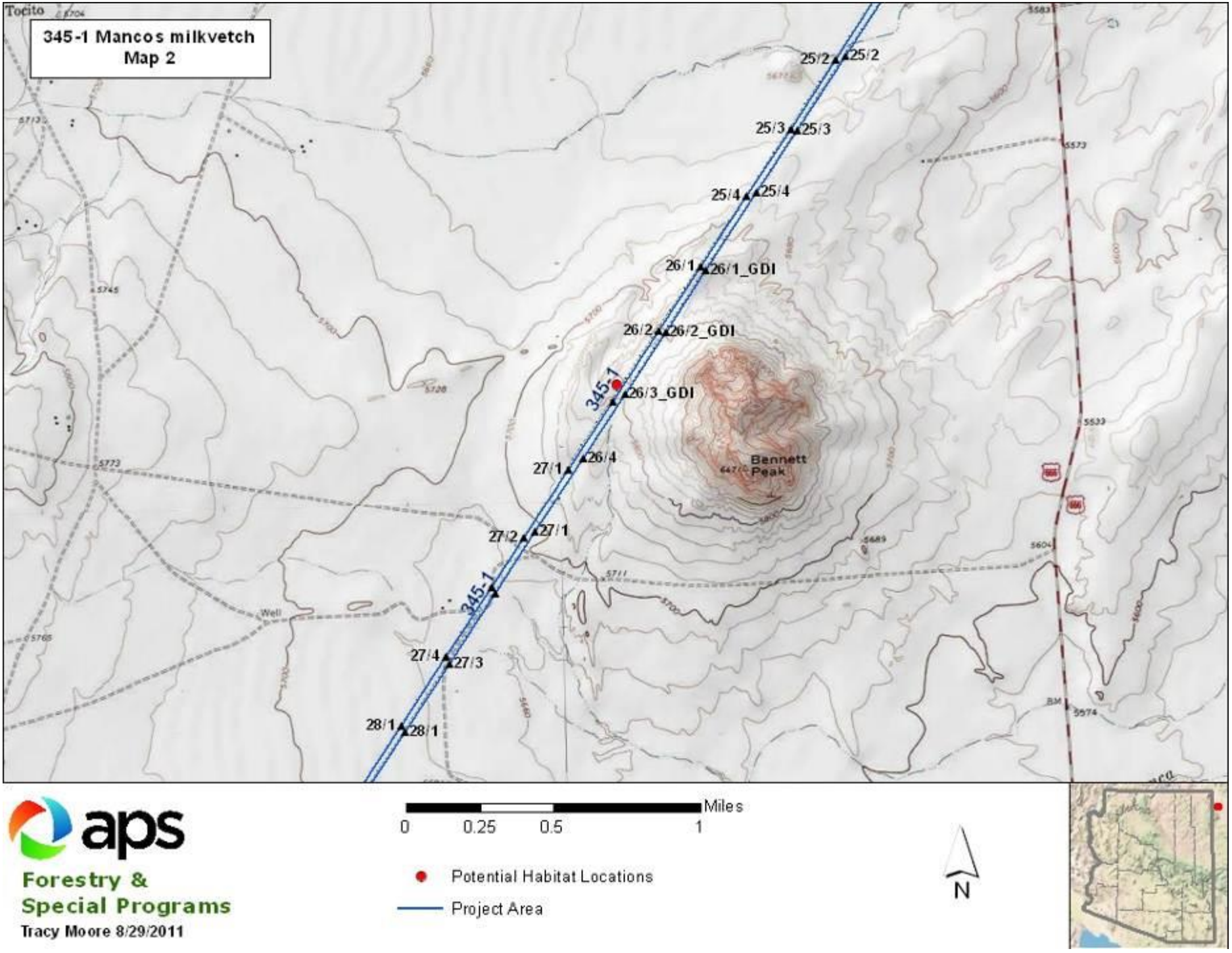
345-1 Mancos milkvetch
Map 2
Tocito
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Bennett Peak
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Potential Habitat Locations
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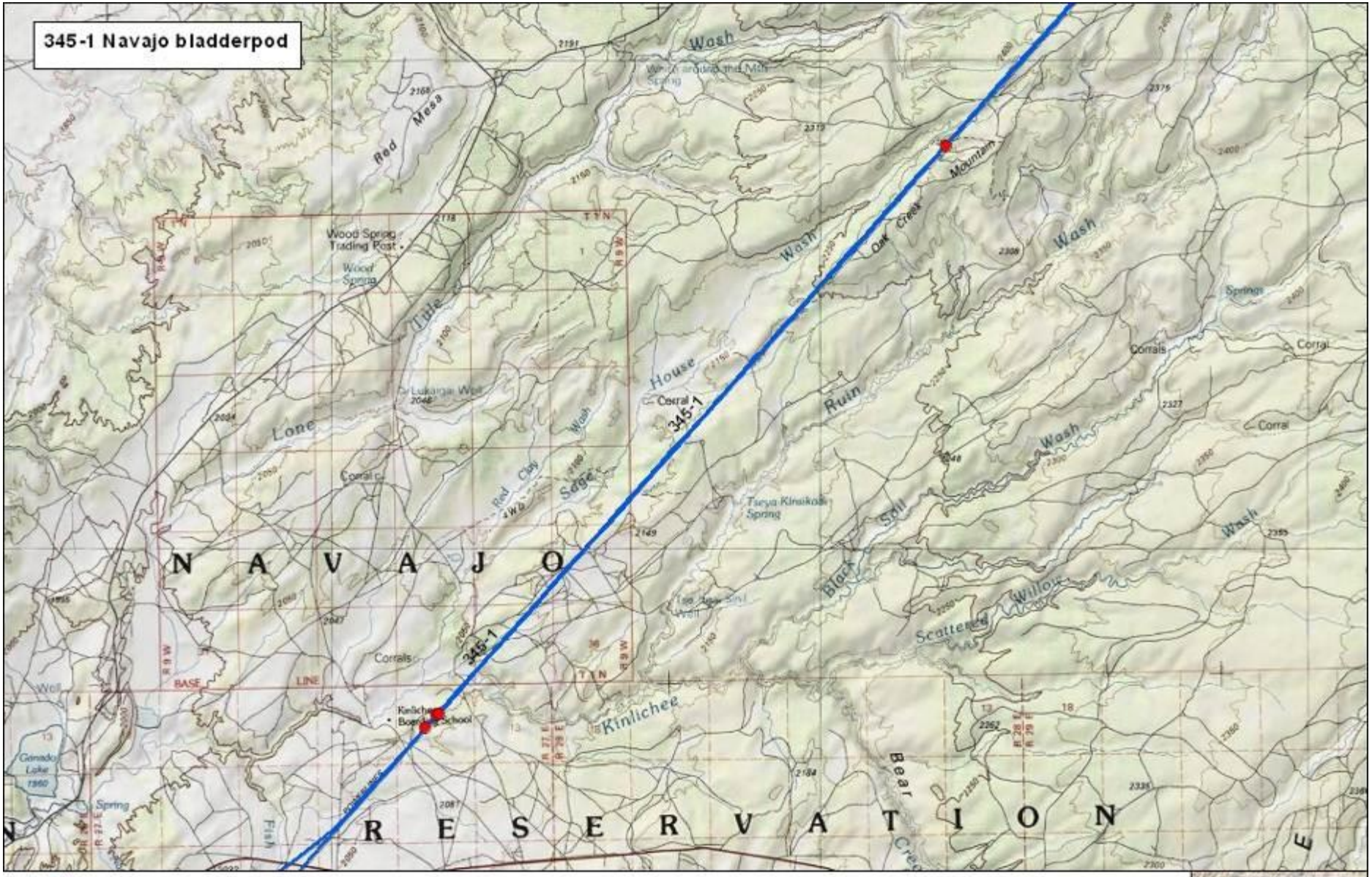

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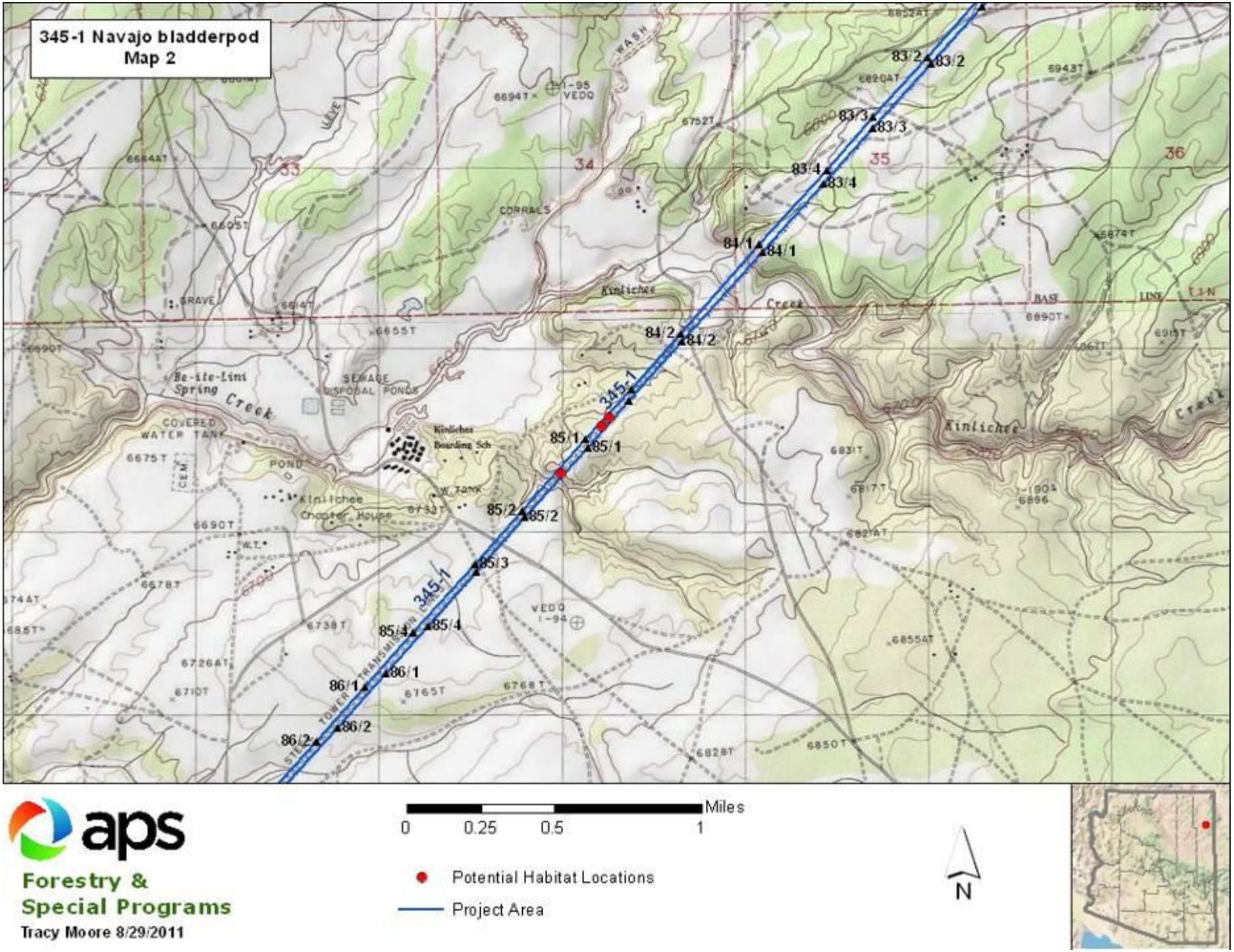

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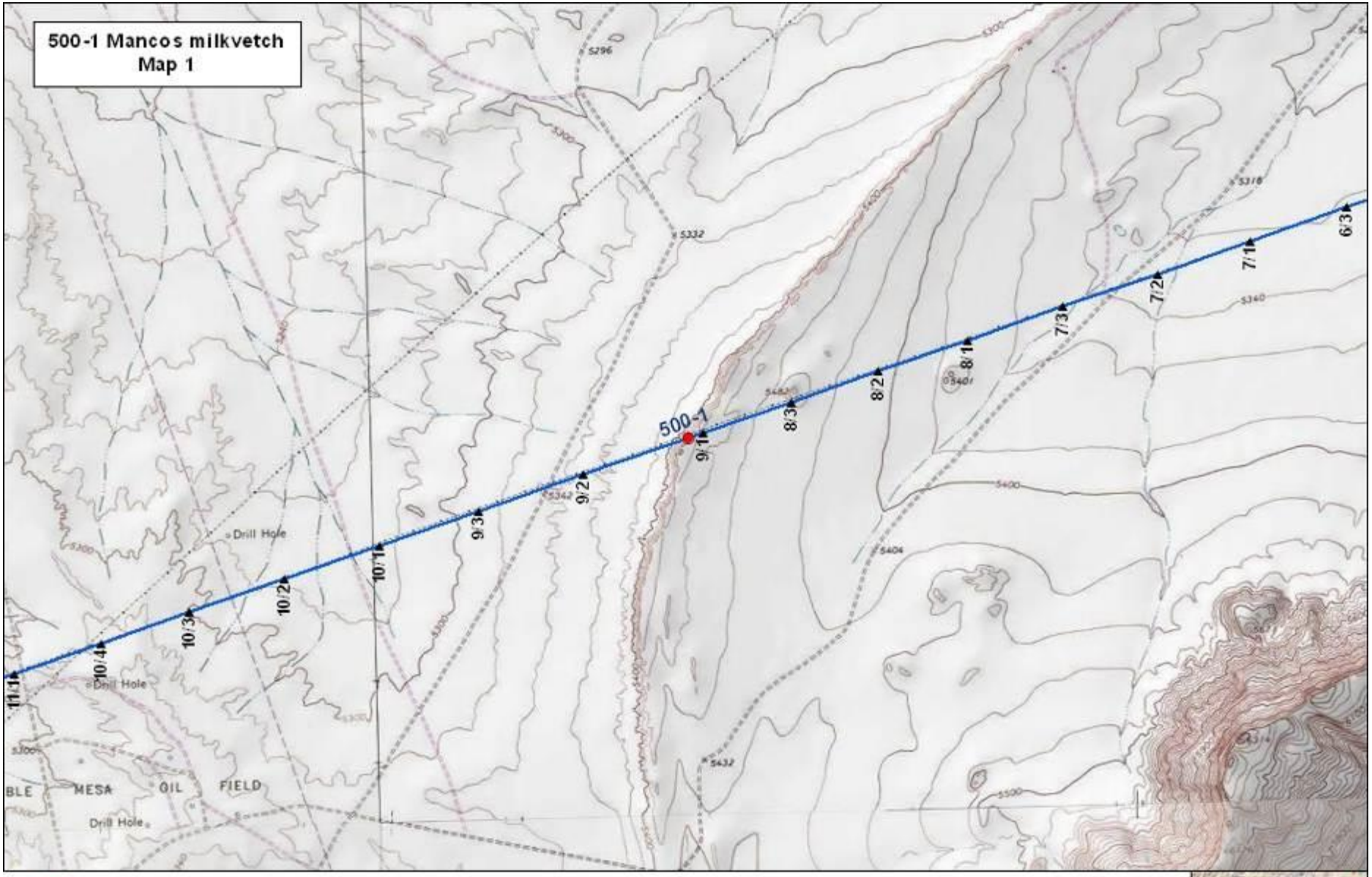
500-1 Mancos milkvetch
Map 1
500-1
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7/3
7/2
7/1
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Drill Hole
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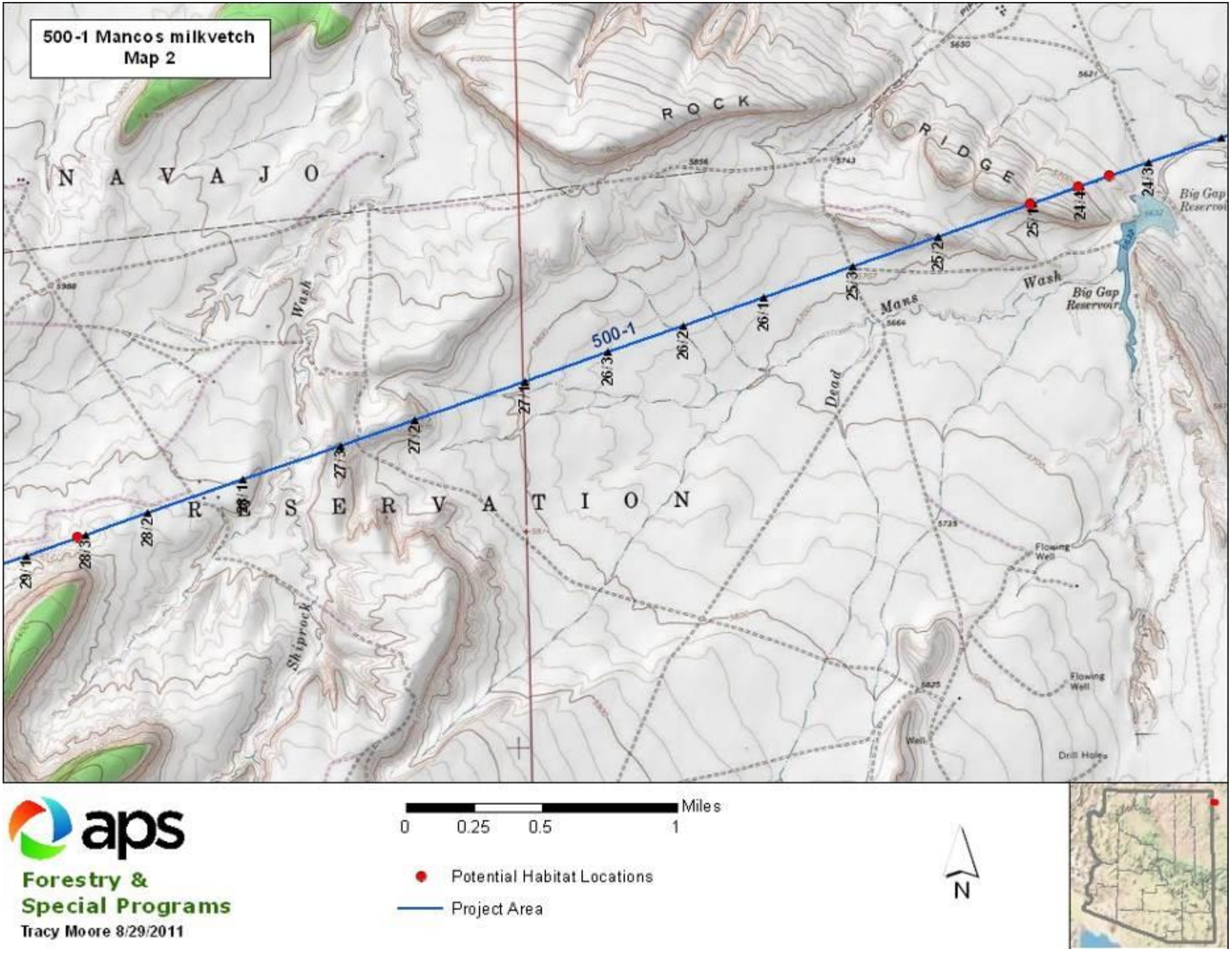
500-1 Mancos milkvetch
Map 2
ROCK
RIDGE
NAVAJO
RESERVATION
Wash
Wash
Dead
Mans
Big Gap
Reservoir
Big Gap
Reservoir
500-1
Shiprock
Flowing
Well
Flowing
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Drill Hole
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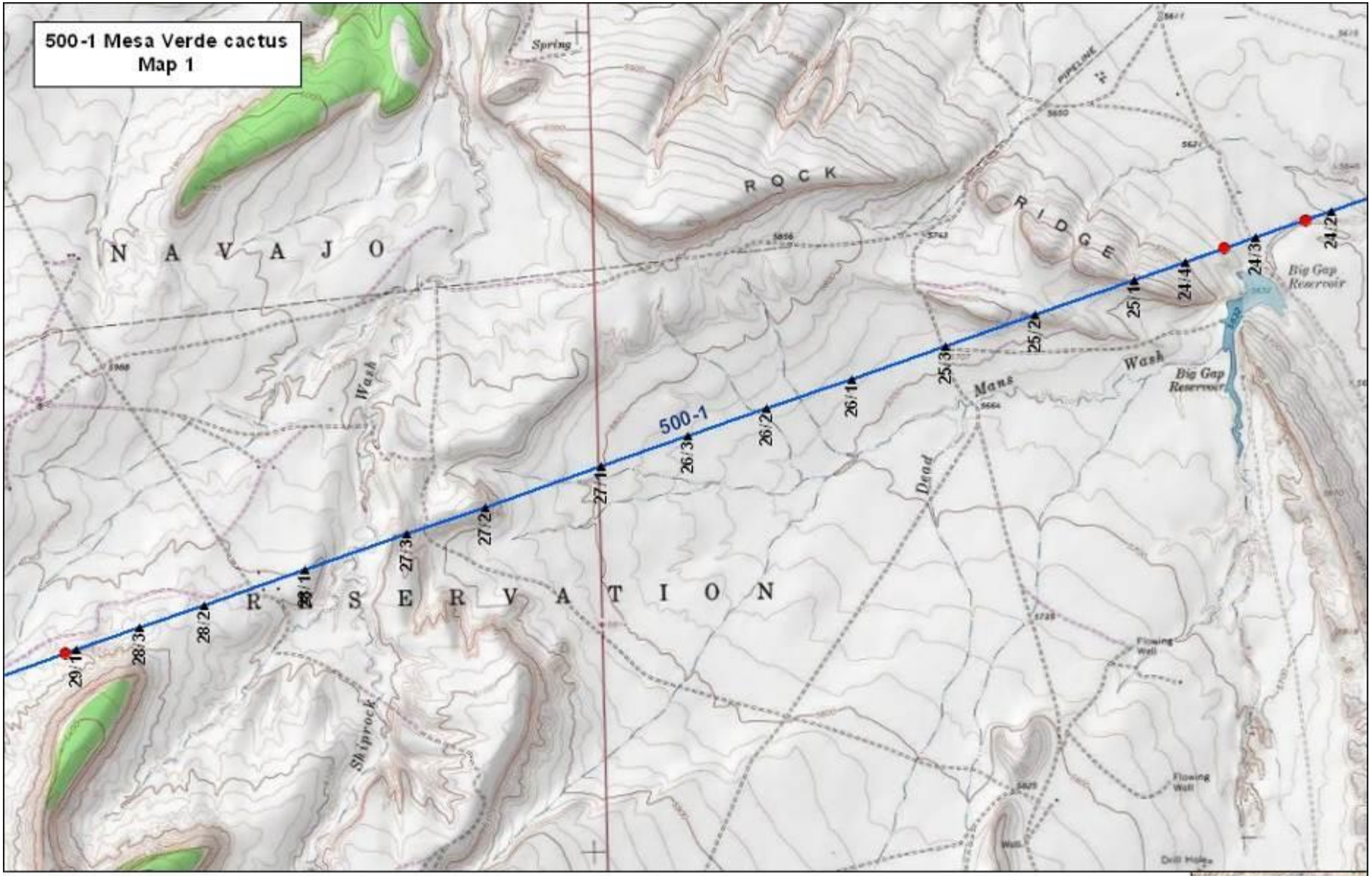

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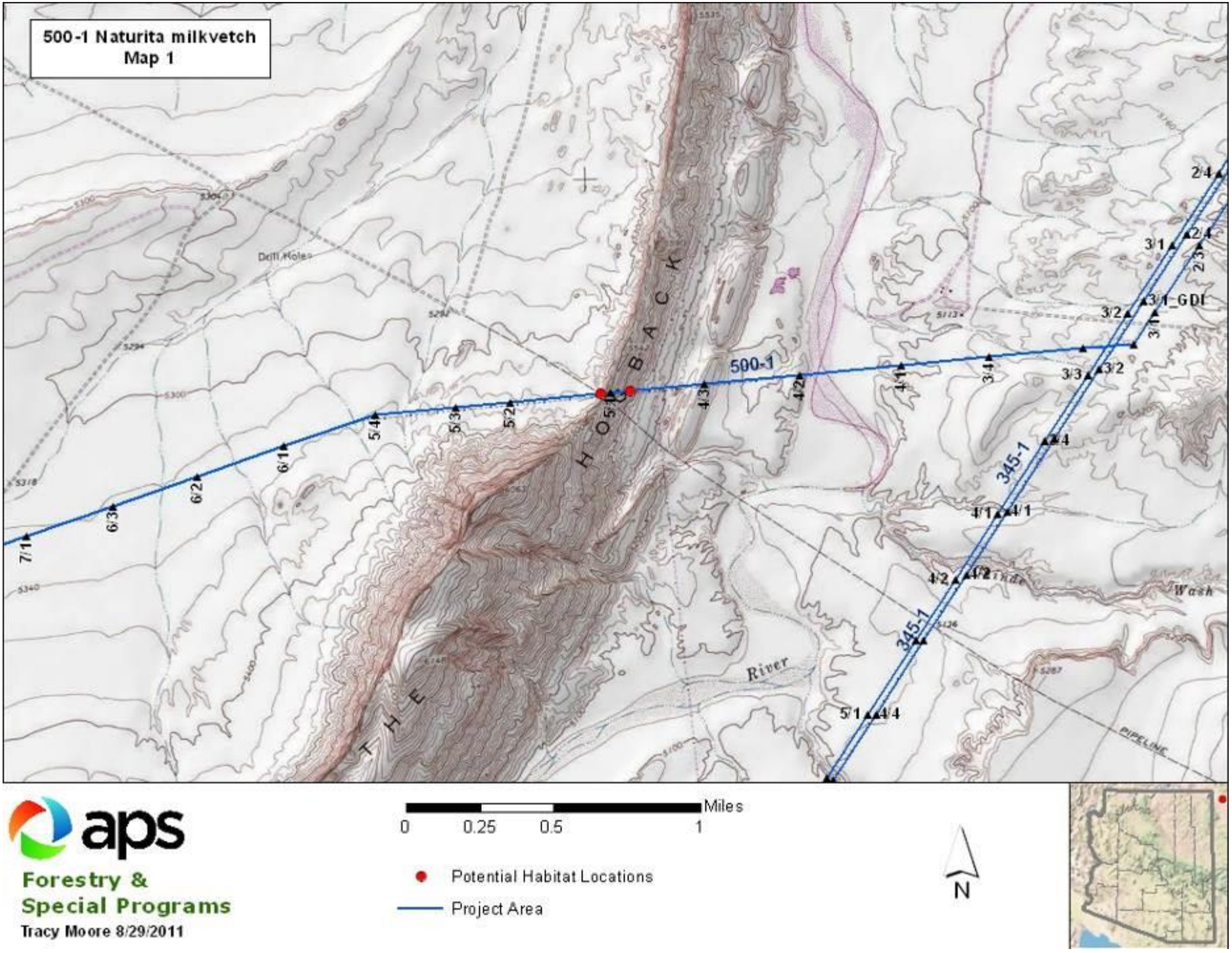
500-1 Naturita milkvetch
Map 1
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345-1
HOOK BACK
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River
Wash
PIPELINE
Drill Hole
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Special Programs
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Potential Habitat Locations
Project Area
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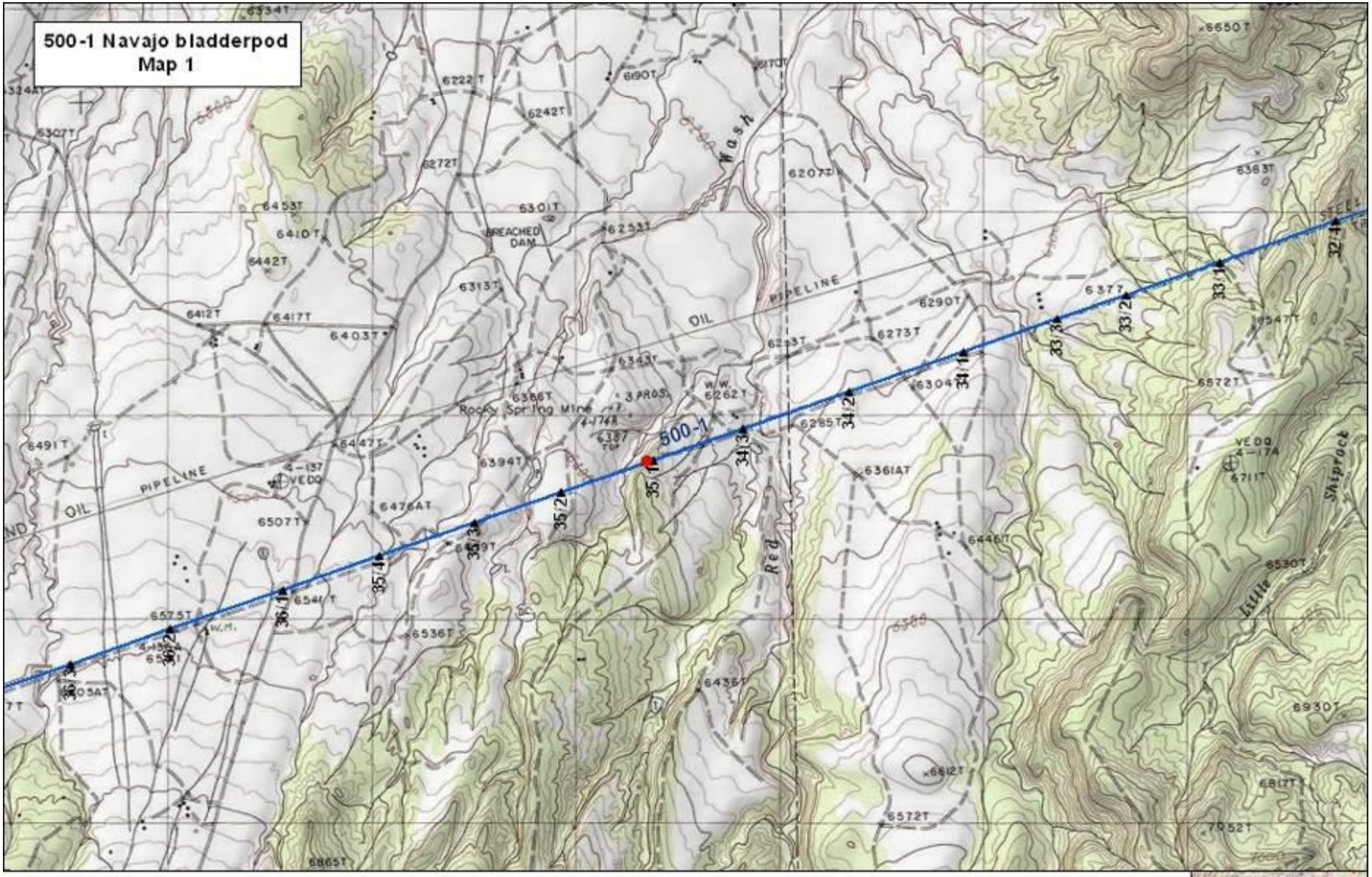

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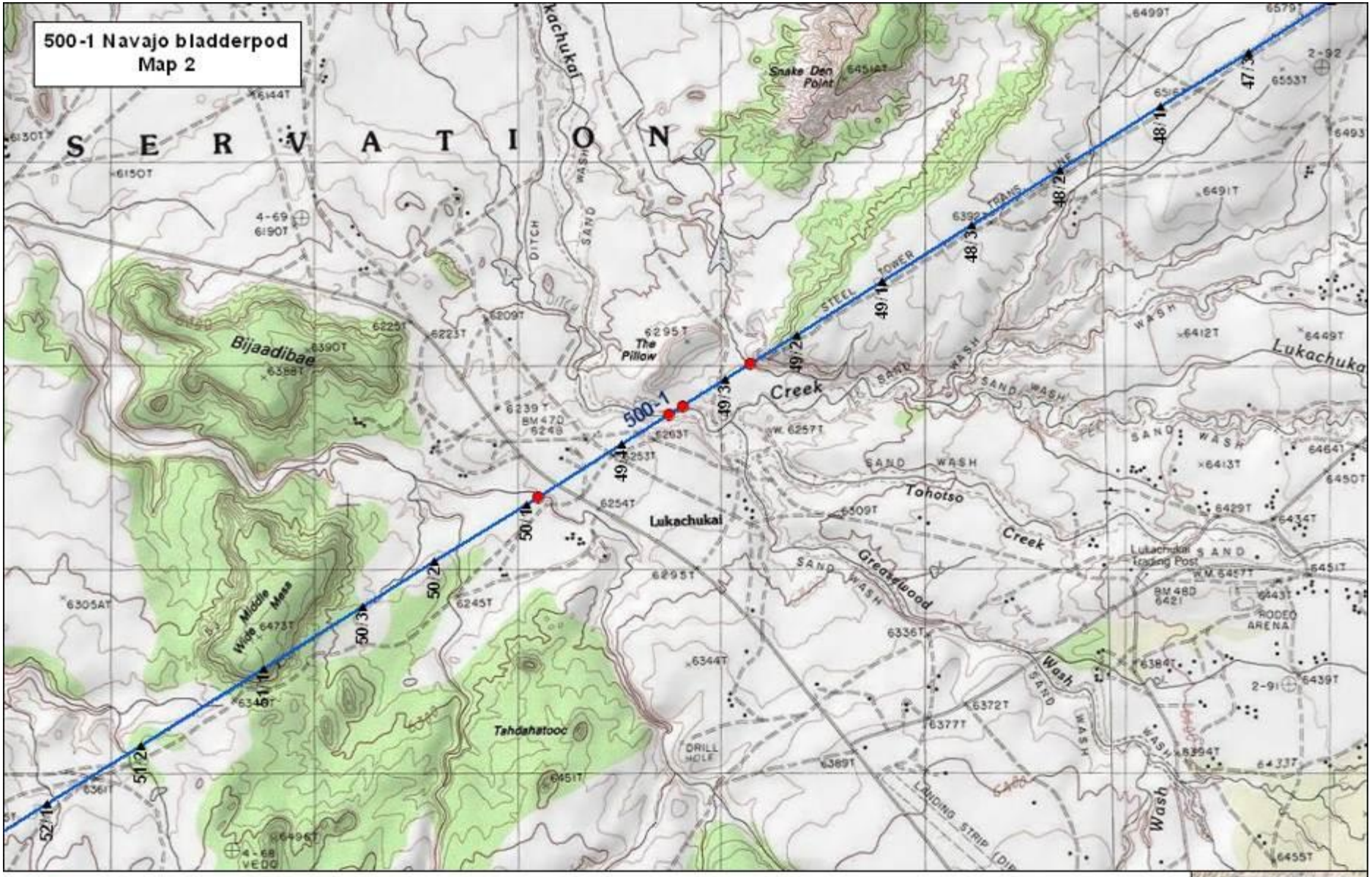

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Forestry & Special Programs

Tracy Moore 8/29/2011

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Potential Habitat Locations

Project Area

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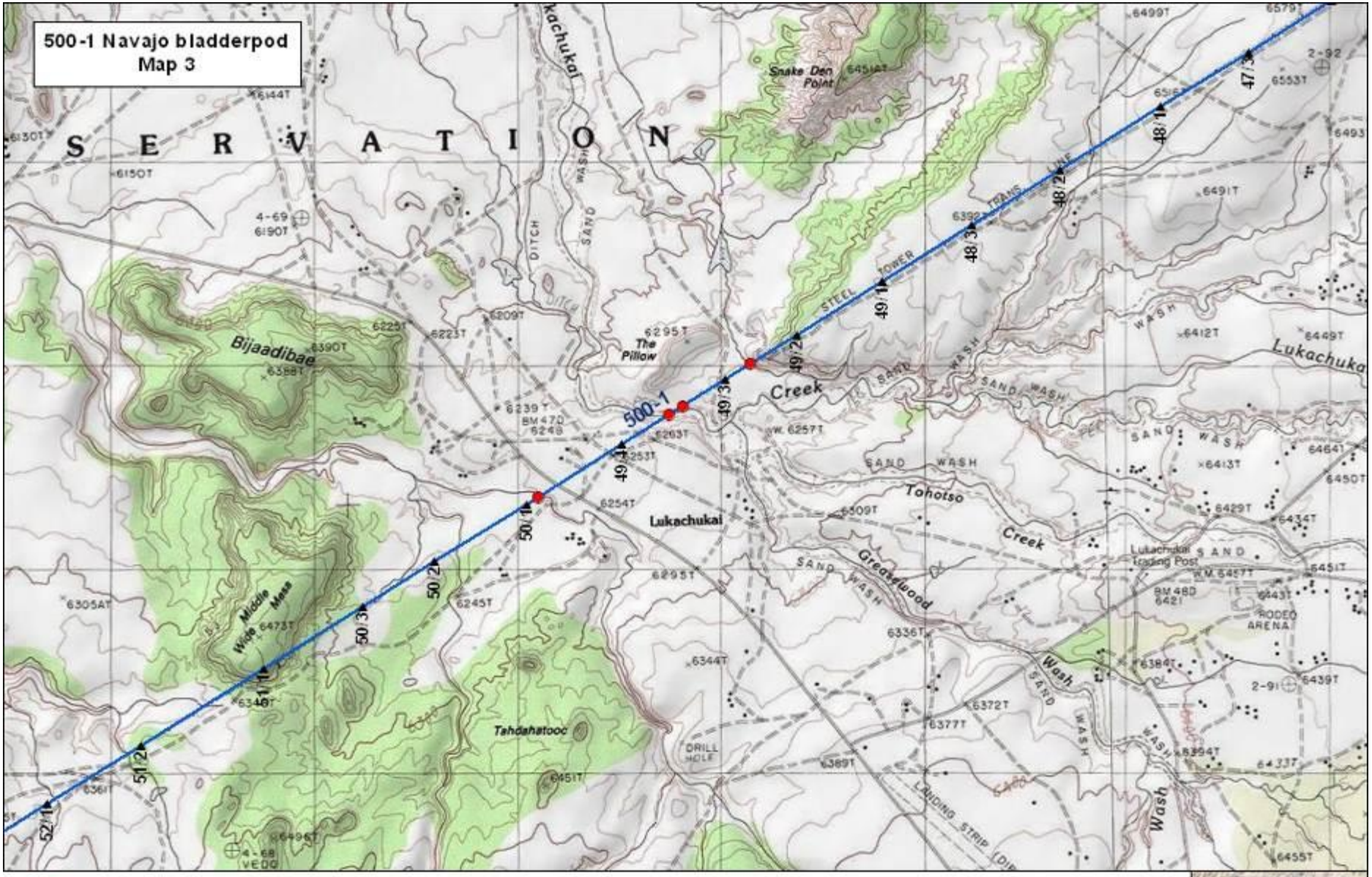

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Forestry &
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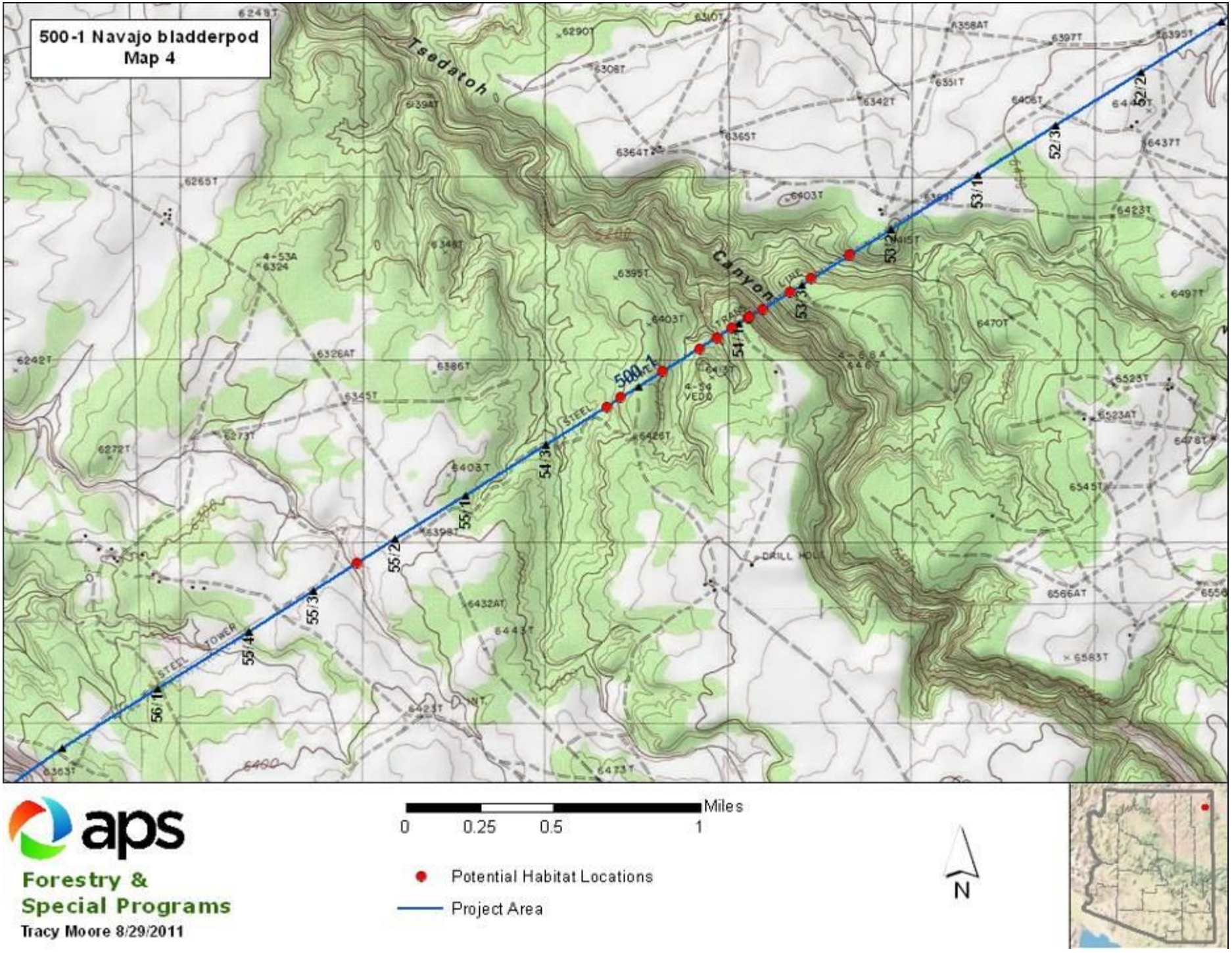

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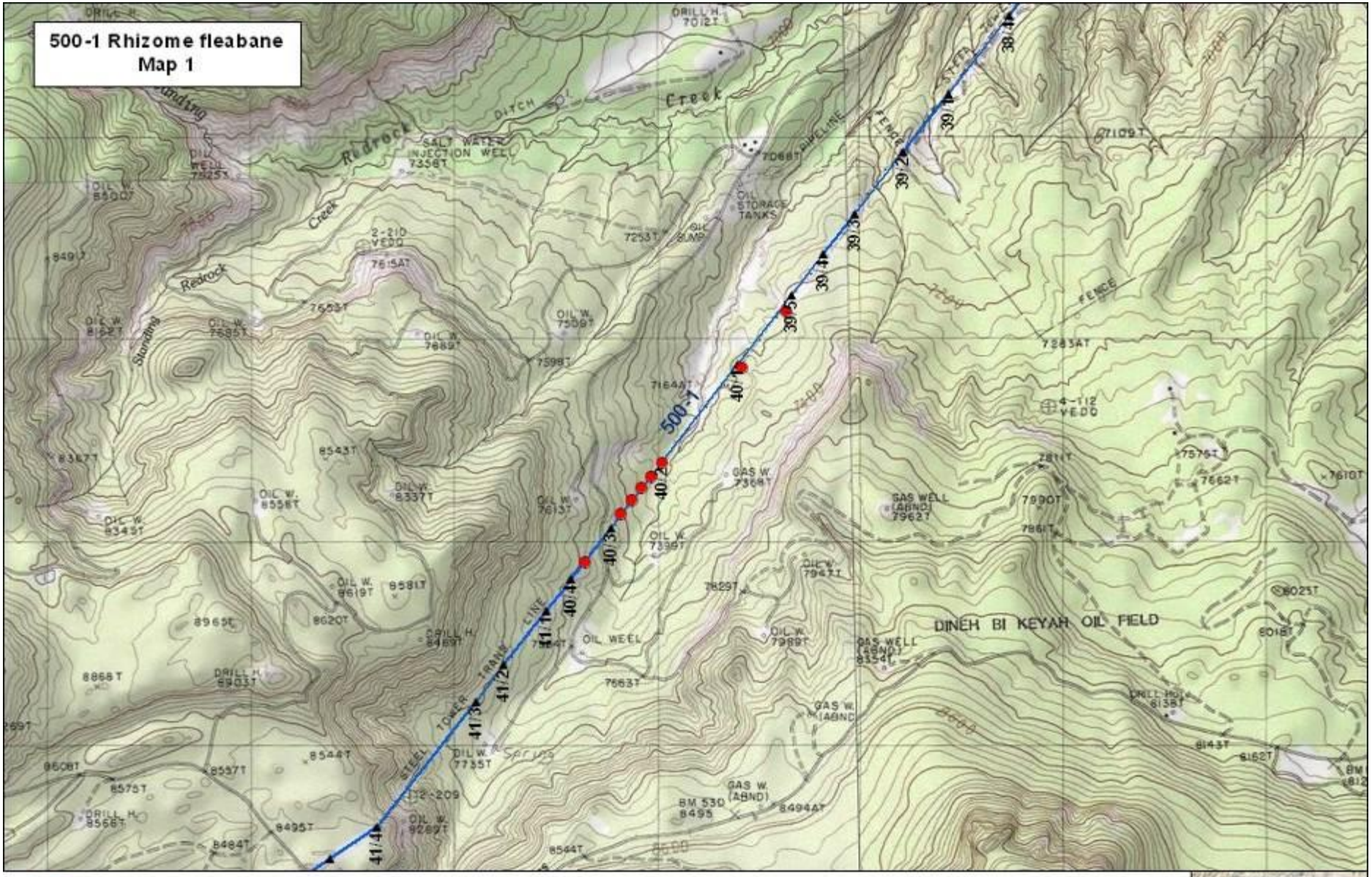
Forestry &
Special Programs

Tracy Moore 8/29/2011



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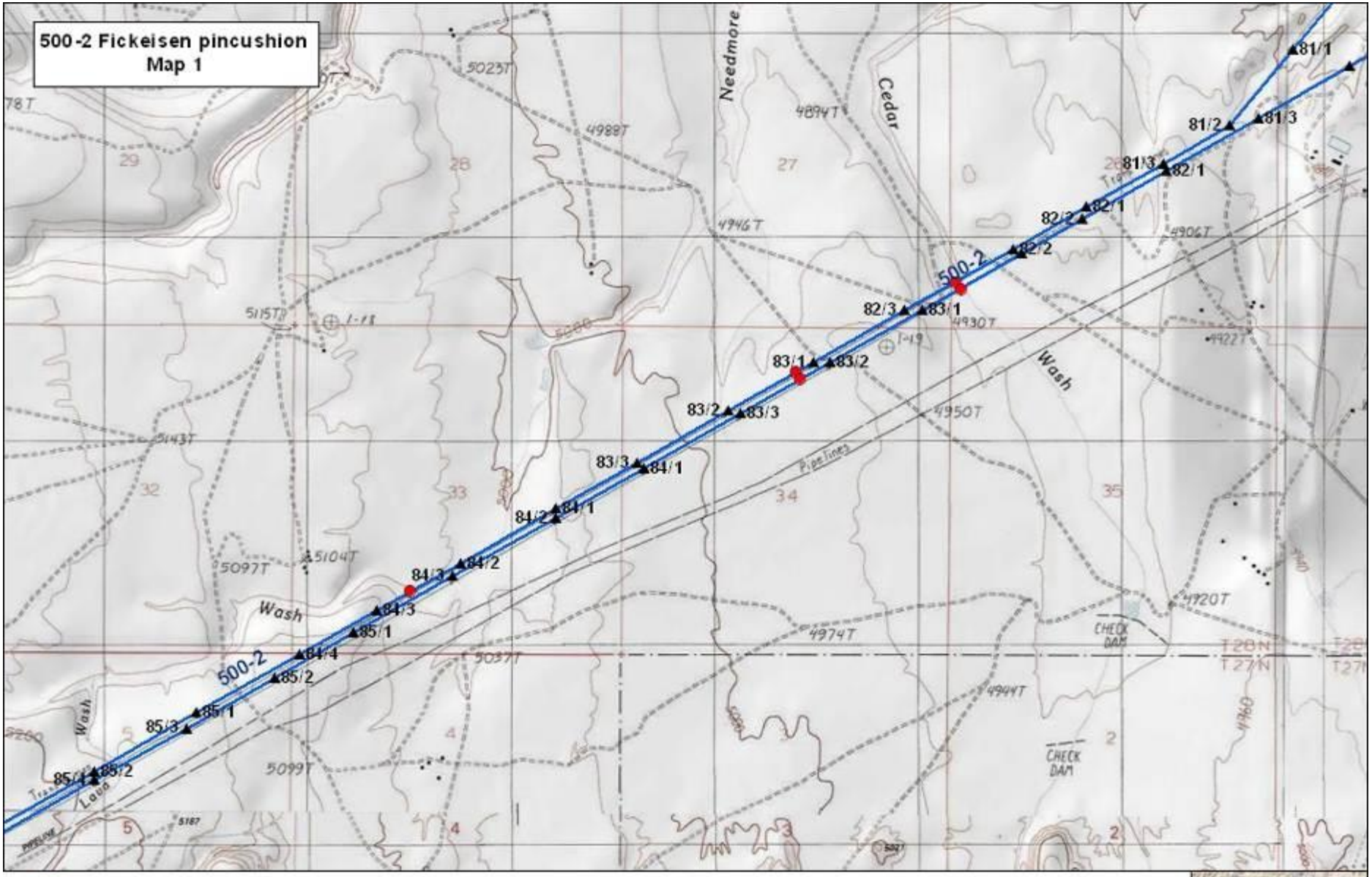
Tracy Moore 8/29/2011



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Forestry &
Special Programs

Tracy Moore 8/29/2011

Appendix D: Faxed Signature Page & Delegation of Authority Letter

Signatures:

Prepared By:

Jennifer Cleland, Contracted Services, APS Forestry and Special Programs — August 26, 2011 Date

Approved By:

Navajo Nation, Fish and Wildlife Department — 9/16/11 Date

Coordination:

*Tracy Moore, Arizona Public Service Company, Forestry and Special Programs
*Pamela Kyselka, Navajo Nation, Fish and Wildlife Department
*Andrea Hazelton, Navajo Nation, Fish and Wildlife Department
*Chad Smith, Navajo Nation, Fish and Wildlife Department

THE NAVAJO NATION

BEN SHELLY PRESIDENT
REX LEE JIM VICE PRESIDENT

MEMORANDUM:

TO : Kevin Gleason, Wildlife Law Enf. Manager
Department of Fish and Wildlife

FROM : Gloria Tom, Director
Department of Fish and Wildlife

DATE : September 14, 2011

SUBJECT : DELEGATING OF AUTHORITY

I will be out of the office on Wednesday, September 14, 2011 through Friday, September 16, 2011. I am hereby delegating you to act in the capacity of the Director, Department of Fish and Wildlife, effective 8:00 a.m. on Wednesday, September 14, 2011. This delegation shall end at 5:00 p.m. on Friday, September 16, 2011.

Your authority will cover the review and signing off of all routine documents pertaining to the Department of Fish and Wildlife, except for issues that you feel should have the attention of the Director.

ACKNOWLEDGEMENT:

Kevin Gleason, Wildlife Law Enf. Manager
Department of Fish and Wildlife

xc: Fred White, Executive Director, DNR

Tracy Moore
Forestry & Special Programs
300 N Granite St
Prescott, AZ 86301

October 24, 2011

Re: Migratory Bird Mitigation for the APS Transmission Herbicide Project
on the 500-1, 500-2 and 345-1 Power Lines.

Dear Ms. Kyselka,
Thank you for the opportunity to meet with you and to demonstrate our operation, practices, and procedures for the Herbicide Project on Friday, October 21, 2011.

The power line corridors on the Navajo Nation are maintained to discourage the growth of all tall growing species such as pines, oaks, junipers, aspen, etc. and dense vegetation that might pose a fire fuel load concern in order to remain compliant with the FAC-003 Reliability Standard. As you mentioned, the openness of the right-of-way (ROW), the sparseness of the vegetation, and the immaturity of the vegetation re-growth makes it unlikely that ground nesting birds will utilize the ROW for nest locations as there is no cover available to them.

Per our discussion, APS is modifying our mitigation plan concerning migratory bird species for the Transmission Herbicide Project on the 500-1, 500-2, and 345-1 power lines as follows:

1. The contractor will, when driving the spray vehicle within the power line corridor between April 15 and August 15, watch for ground nesting birds. If any are seen, the operation will be stopped and the area completed utilizing handheld or backpack sprayers, while keeping the quad/UTV mounted sprayers on the existing road.
2. At any location where the vegetation density is sufficient to provide adequate cover for nest sites, for example dense stands of oaks in the Chuska Mountains, or riparian areas like the Chinle Wash and Little Colorado River, the area to be treated will be surveyed by the contractor for nests prior to spraying. If nests are found during the survey or encountered during the course of the application, spraying will cease and be postponed until after August 15.
3. At sites that cross riparian habitat, the vegetation adjacent to the power line corridor may be suitable nesting habitat and will be avoided.

With the above mitigations in place there should be no adverse impacts to migratory birds within the ROW.

We appreciate you taking the time to meet with us. Please feel free to contact us at any time regarding the project.

Sincerely,

Tracy Moore

Tracy Moore
Natural Resource Specialist II

APPENDIX E

NAVAJO PROJECT

BEST MANAGEMENT PRACTICES AND MITIGATION MEASURES FOR FACILITIES ON THE NAVAJO NATION

Best Management Practice and Mitigation Measures	NGS Plant Site, Pump Station, and Ash Disposal Site	Rail Line to Kayenta Mine	Western Transmission System	Southern Transmission System
General Operational Measures				
Following completion of any construction activities, all tools, equipment, barricades, signs, surplus materials, debris, and rubbish would be removed from the project work limits upon completion.	**X**	**X**	**X**	**X**
Air Quality				
Routine maintenance, repair, and efficiency improvements to air pollution control systems at NGS plant.	**X**			
Ongoing maintenance of coal handling and dust suppression system at NGS plant to minimize dust and control combustible coal dust particles.	**X**			
Operation and maintenance of Glen Canyon air monitoring station.	**X**			
Vehicle access restricted to existing access roads and within ROW corridors		**X**	**X**	**X**
Vehicles traveling off-road within the WTS and STS ROW will minimize impacts to the landscape and resources to the extent possible, reduce travel speeds, and minimize the number of trips back and forth. 25 MPH is a maximum speed and conditions often dictate much lower speeds.			**X**	**X**
Wildlife				
For routine vegetation maintenance (mechanical and hand clearing) and ground-disturbing maintenance activities, workers will watch for nesting birds. If an active nest is found, the vegetation containing the active nest will be avoided until after the nesting season. If the active nest is in vegetation that is causing a safety or system reliably risk, the utility will coordinate with the USFWS to determine the appropriate removal procedures and assure compliance with the Migratory Bird Treaty Act.	**X**	**X**	**X**	**X**
If raptor nests are found on system infrastructure and nest removal or repair work is necessary, the utility (i.e., SRP, APS, NVE) would coordinate with the USFWS to assure compliance with the Migratory Bird Treaty Act and Bald and Golden Eagle Act, as appropriate.	**X**	**X**	**X**	**X**
Herbicide treatments BMPs: • Between April 15 and August 15, the spray vehicle will watch for ground nesting birds. If any are seen, the operation will be stopped and the area completed utilizing handheld or backpack sprayers. • At any location where the vegetation density is sufficient to provide adequate cover for nest sites, for example dense stands riparian areas, the area to be treated will be surveyed by the contractor for nests prior to spraying. If nests are found during the survey or encountered during the course of the application, spraying will cease and be postponed until after August 15 or until the nest is inactive. • All vehicles will be operated in a safe and prudent manner during daylight hours, maintaining speeds of 15-20 miles per hours within the ROW.				**X**
As transmission and lower voltage power lines are replaced and maintained, installed equipment will meet the most current Avian Power Line Interaction Committee (APLIC) design standards to prevent bird electrocutions.	**X**	**X**	**X**	**X**
Speed limits would minimize vehicular collisions with wildlife and decrease fugitive dust emissions.	**X**	**X**	**X**	**X**

Best Management Practice and Mitigation Measures	NGS Plant Site, Pump Station, and Ash Disposal Site	Rail Line to Kayenta Mine	Western Transmission System	Southern Transmission System
Excavation sites would be monitored or covered to avoid trapping wildlife, and routes of escape for wildlife would be maintained. The construction site would be inspected daily for appropriate covering and flagging of excavation sites. Each morning the construction site would be inspected for wildlife trapped in excavation pits.	X	X	X	X
While working in riparian areas, workers will reduce the number of trips in and out, use hand crews if possible, minimize time spent working within the riparian area, and/or stage vehicles and materials outside riparian areas, if possible.			X	X
Threatened, Endangered, and Sensitive Species				
Biologically sensitive areas as identified in the EA and Biological Assessment will be marked or mapped prior to construction or maintenance actions, by the utility and the appropriate measures will be implemented to avoid and/or minimize impacts to known populations of threatened, endangered, or sensitive species (see species-specific measures below).		X	X	X
Prior to ROW vegetation treatments, ground-disturbing maintenance actions, or ground-disturbing maintenance actions to access roads, the segments of ROW or access roads where listed or sensitive plant species could occur will be surveyed and the locations marked or otherwise delineated to assure treatments (herbicide, mowing, or hand clearing) or maintenance activities will avoid impacts: • Welsh's milkweed (Navajo Nation) • Fickeisen plains cactus (Navajo Nation) • Other listed or sensitive plant species as required in EA and BA		X	X	X
As mapped above, where suitable habitat for sensitive plants exists within the WTS or STS ROWs, vehicles will remain on existing roads while traveling through suitable habitat.		X	X	X
Vegetation				
Herbicide treatments BMPs: • All applicable labels and federal laws, and regulations with regard to the use and application of herbicides will be strictly adhered to. • All herbicide applications will be spot treatments utilizing backpack, handheld, and quad/ATV mounted sprayers with plant specific treatment. • There will be no new roads or ground disturbing activities. • If a portion of the transmission line is inaccessible by road or sensitive habitats occur within the ROW, the crew will drive to the nearest location and walk to the site with the necessary equipment.				X
Vegetation management on WTS and STS systems • Vegetation management would not widen the ROW corridor. • Existing established roads would be used to access powerline ROWs. • Where vehicle access is not available crews would hike in from the nearest access point. • Existing established roads within the powerline ROW would be used, where possible. • Mowers would not be operated on slopes greater than 30%.			X	X

Best Management Practice and Mitigation Measures	NGS Plant Site, Pump Station, and Ash Disposal Site	Rail Line to Kayenta Mine	Western Transmission System	Southern Transmission System
Noxious Weeds				
Ensure that utility mower, track or other off-road equipment, which has high potential to carry noxious weeds (not including service vehicles, pick-up trucks, passenger cars, bucket trucks, or utility vehicles/all-terrain vehicles) are free of soil, weeds, vegetative matter, or other debris that could harbor seeds prior to initiating vegetation management and treatments.		**X**	**X**	**X**
Water Quality				
Rail cars at Coal Loading Station are filled below top to minimize spillage and exposure to wind. Observed spillage is cleaned up after the train leaves.		**X**		
Maintenance of a Spill Prevention, Control and Countermeasure Plan (SPCC) that contains measures used to prevent oil discharges from occurring and actions for responding to a spill in an effective and timely manner to mitigate the impacts of any discharge to a navigable water. Actions in the SPCC Plan include preventative maintenance of equipment and containment and discharge prevention systems; annual employee training; and monthly inspections.	**X**			
On-going operation, maintenance, replacement and improvement of the systems needed to safely and efficiently store oil and chemicals.	**X**			
Implementation of the Groundwater Protection Plan and compliance with CCR regulations to assure protection of N-aquifer aquifer.	**X**			
To protect groundwater, hazardous fluid spill prevention and protection practices would be implemented			**X**	**X**
During repairs and maintenance of project infrastructure, standard BMPs to prevent degradation of surface waters (i.e., spill prevention and capture plans, storm water runoff controls, silt fencing and straw bales, and sediment and erosion controls) would be implemented.	**X**	**X**	**X**	**X**
Staging areas for loading and unloading of equipment will be located in previously disturbed areas, but outside of floodplains and other wet areas.			**X**	**X**
Earth Resources: Soil Loss and Erosion				
Construction, operations, and maintenance activities will be scheduled as feasible to minimize work during periods when the soil is too wet to support construction equipment, which could cause deep ruts, road degradation, and surface disturbance.	**X**	**X**	**X**	**X**
Driving support vehicles or quad/UTV in riparian area will be avoided unless there is/ are established road(s).			**X**	**X**
If traffic control structures (e.g., boulders, barriers, dips) are be moved, they will be returned to the original position when work is complete.		**X**	**X**	**X**
Cultural Resources				
Class III survey will be conducted in areas where activities could impact areas that have not been previously disturbed. If cultural resources sites are found and cannot be avoided, SRP would coordinate NHPA compliance with Reclamation and BIA.	**X**	**X**	**X**	**X**
Health and Safety				
Maintain a safe and healthy environment at NGS facility in accordance with OSHA regulations and the NGS Emergency Response Plan.	**X**	**X**		

Best Management Practice and Mitigation Measures	NGS Plant Site, Pump Station, and Ash Disposal Site	Rail Line to Kayenta Mine	Western Transmission System	Southern Transmission System
Ongoing repair and maintenance of railroad track, catenary, crossing locations, gates, signals, signage, roads drainage and cattle guards to ensure safe train operations. Regular train maintenance and inspections with emphasis on the braking system and integrity of cars.		**X**		
Use of visual and auditory signals for train operation.		**X**		
Coal handling facilities at NGS plant including dust extractors and openings will be maintained to ensure ventilation in the coal conveyor for personnel ventilation and to reduce the risk of coal dust explosions.	**X**			
Periodic transmission and power line inspections to meet federal and industry reliability and safety standards.	**X**		**X**	**X**
Periodic inspections and overhaul of sub-synchronous resonance yard.	**X**			
Maintenance of fire protection system for transformers.	**X**			
Regular monitoring and maintenance of the NGS switchyard.			**X**	**X**
Regular inspection, maintenance, and repair of communication sites	**X**	**X**		**X**
During herbicide treatments: • All applicable labels, federal laws, and regulations with regard to the use and application of herbicides will be strictly adhered to. • Crew members will consist of licensed herbicide applicators. • Applicants will wear the maximum personal protection equipment for each herbicide being applied. Crews will have telephones, chemical spill kits, shovels, first-aid kits, fresh water, and emergency phone numbers with them.				**X**
For transmission corridor vegetation and line maintenance, fire restrictions will reviewed and followed, and appropriate measure taken during periods of high fire risk: a. Contractors and utility workers will have one fire tool per person at the vegetation treatment site. b. Each truck will have one Indian Water Pump on site. c. Mowers will have 500 gallon Water Tenders on site d. For STS, APS leadership personnel are red carded.			**X**	**X**
SRP, APS, and NVE will maintain existing safety programs and information and education programs to reduce risks to the public and to property from activities on or near NGS Project facilities. . The objectives of the Public Safety program may include: • Ensure public knowledge of and compliance with the applicable electrical safety laws, regulations, codes, and standards. • Ensure that the public and first responders are made aware of the electrical hazards relating to activities on or near electrical facilities. • Ensure that all public safety-related incidents and activities are evaluated with respect to applicable laws, codes, regulations and standards and that timely consultation and recommendations are provided. • Provide continuous input to administering bodies on the adequacy and applicability of codes related to NGS Project facilities.	**X**	**X**	**X**	**X**

Best Management Practice and Mitigation Measures	NGS Plant Site, Pump Station, and Ash Disposal Site	Rail Line to Kayenta Mine	Western Transmission System	Southern Transmission System
Waste Management				
On-going maintenance and management of waste management facilities including solid waste landfill, asbestos landfill, and CCR disposal site in accordance with applicable regulations.	**X**			
Implementation of Hazardous Waste Minimization Plan using the best available and affordable waste management methods to minimize waste generation.	**X**			
Monitoring and maintenance of waste water system to prevent leakage, spills, and maintain zero liquid discharge.	**X**			
Regular maintenance sludge removal at sewage treatment facility.	**X**			
Implementation of Hazardous Waste Minimization Plan.	**X**			
Implementation of Groundwater Protection Plan and CCR regulations.	**X**			
Recreation				
If vegetation maintenance is required in areas of Wild and Scenic Rivers, APS will treat vegetation using hand crews and not by mechanical methods.				**X**
When scheduling the timing of work activities, APS will coordinate with the AZ Game and Fish Department to determine hunting seasons within game management unit 21 on the Agua Fria National Monument. APS will be considerate of the hunting season and will schedule work during the most appropriate time to reduce interaction with hunters and avoid negative impacts during the hunting seasons as much as possible.				**X**

APPENDIX F

NAVAJO PROJECT

EXECUTIVE SUMMARY OF ASH DISPOSAL AREA BORINGS

TO: **Paul Ostapuk, NGS O&M Baseload Generation Manager**

FROM: **Paul Harn P.E., Sr. Mechanical Engineer, NGS**

DATE: **April 24, 2014**

RE: **Summary of NGS Ash Disposal Area Bore Sampling**

Fourteen borings were taken in April 2014 of the materials in the NGS Ash Disposal Area. Moisture samples were taken every 10 feet in each borings.

Original ash deposits at the bottom of the ash disposal area are extremely hard. The drill rig struggled to drill into the layer. No borings went through this hard layer. The layer is not considered permeable; therefore it is highly unlikely that water will migrate down through this layer. It appears the layer is comprised of a mixture of fly ash and bottom ash at optimum moisture and compacted. The hard layer exists on the majority of the bottom of the ash disposal area. The hard layer is at a higher elevation at the west edge of the area and may act as reinforcement of the earthen dam.

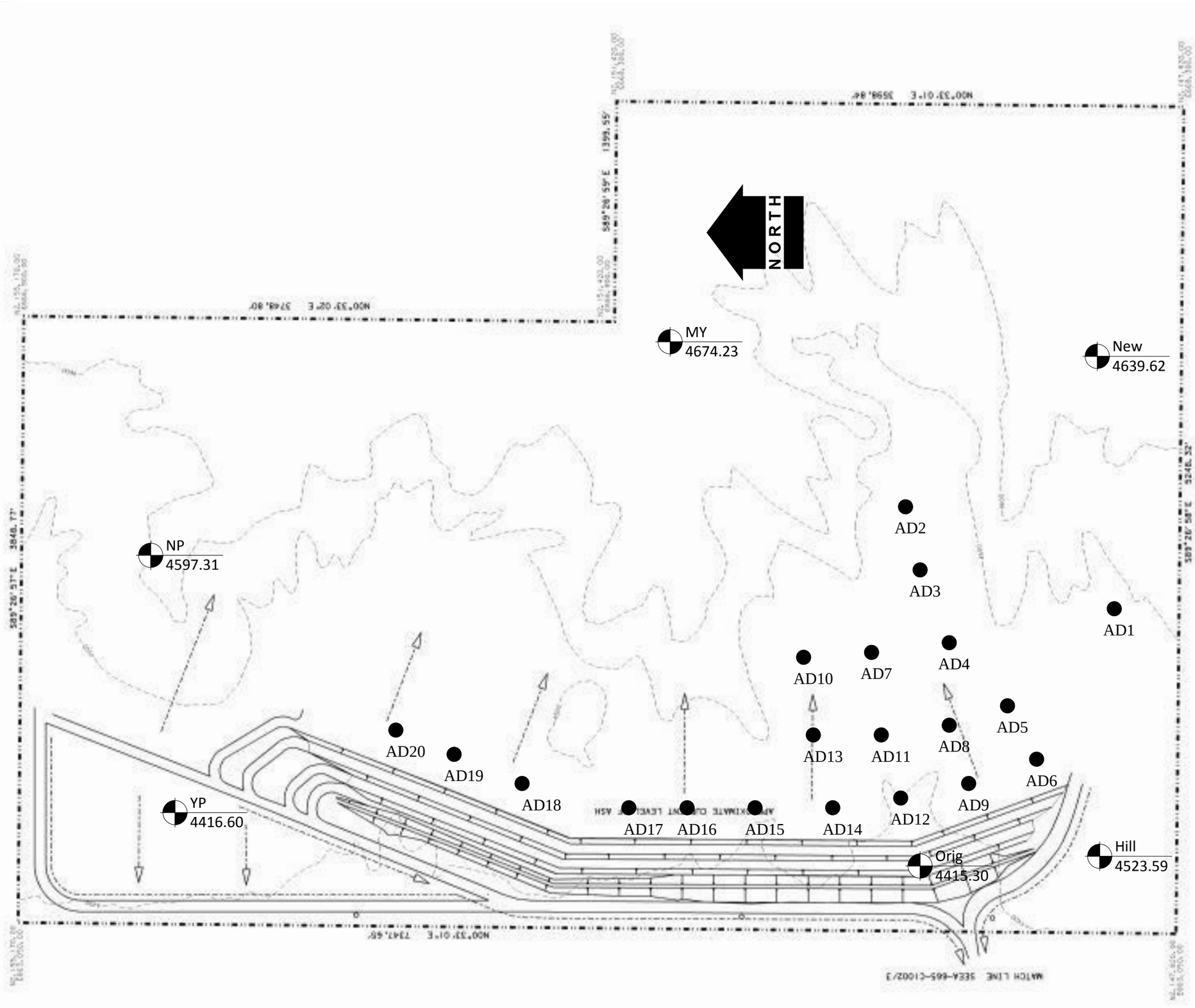
The moisture samples taken where varying from extremely dry at 4 to 5 percent and 15 to 20 percent. One moisture sample appeared to be scrubber sludge which was over optimum moisture. Below that optimum sample the moisture sample were much dryer. A good sign that moisture in the ash disposal area is staying in the layers they were originally were deposited in. We saw no signs of moisture migrating to the bottom of the disposal area.

We found no traces of petroleum products in the samples.

The yearly average evaporation rate for Page AZ is over 80 inches per year. The yearly rainfall is less than 8 inches per year. Consequently, precipitation will not cause moisture to migrate through the ash disposal area either.

My conclusion from the work performed this year is that the monitoring wells below the ash disposal dam will not see any water migrating through the ash disposal area and west into the wells.

Attachments: Boring Sample Locations and Results



AERIAL CONTROL PANEL LOCATIONS			
NAME	NORTH	EAST	ELEVATION
Orig	N 2,149,355.44	E 663,293.69	EL. 4415.30
YP	N 2,152,520.50	E 663,592.90	EL. 4416.60
NP	N 2,153,715.04	E 665,353.03	EL. 4597.31
MY	N 2,150,852.31	E 666,650.71	EL. 4674.23
New	N 2,148,279.90	E 666,716.80	EL. 4639.62
Hill	N 2,148,408.83	E 664,067.53	EL. 4523.59

BORING LOCATIONS			
NAME	NORTH	EAST	ELEVATION
AD1	2148707.333	664898.480	4517.140
AD2	2149399.567	665587.362	4519.468
AD3	2149454.370	665295.537	4526.056
AD4	2149296.632	664973.120	4522.359
AD5	2149296.632	664973.120	4522.359
AD6	2149051.249	664336.354	4530.625
AD7	2149916.740	665169.442	4526.935
AD8	2149631.722	664653.463	4527.271
AD9	2149490.859	664192.390	4530.920
AD10	2150257.619	665049.523	4529.190
AD11	2149894.874	664568.551	4526.438
AD12	2149794.572	664153.390	4530.116
AD13	2150272.568	664445.650	4524.117
AD14	2150095.746	664138.510	4527.800
AD15	2150381.453	664123.378	4526.550
AD16	2150646.768	664132.757	4525.939
AD17	2150983.781	664070.087	4524.296
AD18	2152288.181	664272.777	4517.919
AD19	2152565.574	664364.323	4518.967
AD20	2152870.848	664482.747	4517.660

Boring Locations ● AD1

Panel Points ⊕ New 4639.62

TITLE

April 8, 2014
Ash Disposal Area
Aerial and Density Surveys

Dwg. Rev. No. A-665-1002/2 BY PAUL HARN

2014 Results of the GPS Suvey

Coordinates from DWG A-665-1002	1	2149355.440	663293.690	4415.300	ORIG	
	2	2152520.500	663592.900	4416.600	YP	
	3	2153715.040	665353.030	4597.310	NP	
	4	2150852.310	666650.710	4674.230	MY	
	5	2148279.900	666716.800	4639.620	NEW	
	6	2148408.830	664067.530	4523.590	HILL	
Base Pt	100	2152018.042	666322.973	4641.914	IPOCJMLSCP	
GPS Coordinates on Panel Points	101	2149356.041	663294.845	4415.472	BCORIG	
	102	2152520.634	663592.147	4416.348	BCYP	YP Cap Elevation
	103	2153715.311	665352.614	4597.550	BCNP	
	104	2150851.366	666650.787	4674.067	BCMY	
	105	2148279.359	666717.005	4639.667	HUBNTACK	
	106	2148409.308	664067.263	4523.545	BCHILL	
	107	2152520.443	663592.380	4416.927	BCYPGRND	YP Ground Elevation
	110	2151420.977	666899.725	4664.844	BCCORNER7	
	111	2151291.413	667260.793	4680.601	BC	
Bore Location Coordinates	201	2150257.619	665049.523	4529.190	BOREAD10	
	202	2150272.568	664445.650	4524.117	BOREAD13	
	203	2149894.874	664568.551	4526.438	BOREAD11	
	204	2149631.722	664653.463	4527.271	BOREAD08	
	205	2149296.632	664973.120	4522.359	BOREAD05	
	206	2150381.453	664123.378	4526.550	BOREAD15	
	207	2150646.768	664132.757	4525.939	BOREAD16	
	208	2150983.781	664070.087	4524.296	BOREAD17	
	209	2152288.181	664272.777	4517.919	BOREAD18	
	210	2152565.574	664364.323	4518.967	BOREAD19	
	211	2152870.848	664482.747	4517.660	BOREAD20	
	212	2150095.746	664138.510	4527.800	BOREAD14	
	213	2149794.572	664153.390	4530.116	BOREAD12	
	214	2149490.859	664192.390	4530.920	BOREAD09	
	215	2149051.249	664336.354	4530.625	BOREAD06	
	216	2149916.740	665169.442	4526.935	BOREAD07	
	217	2149296.632	664973.120	4522.359	BOREAD04	
	218	2149454.370	665295.537	4526.056	BOREAD03	
	219	2149399.567	665587.362	4519.468	BOREAD02	
	220	2148707.333	664898.480	4517.140	BOREAD01	

TITLE

April 8, 2014
Ash Disposal Area
Aerial and Density Surveys

MIKON CORPORATION
Consulting Engineers
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CLIENT			
SRP			
PLANT	STOCKPILE		
Navajo	Ash		
DATE	PROBE	BARREL	LOAD CELL
04-17-14	16	B	E

NUCLEAR GAUGE CALIBRATION

POINT NUMBER	Fly/Loose
1402	
1423	
1394	
1401	
1379	
1416	
1400	
1406	
1412	
1412	
1403	
1438	
1404	
1406	1056.0
1414	
AVERAGE	1407.3
TOTAL WEIGHT	~~1056.0~~ 1407.0
TARE WEIGHT	372.5
COAL WEIGHT	
VOLUME	9.39
WET DENSITY	71.8

POINT NUMBER	Drop 1
1277	
1285	
1274	
1269	
1285	
1264	
1272	
1287	
1279	
1301	
1264	
1279	
1275	
1275	1113.5
1271	
AVERAGE	1,277.1
TOTAL WEIGHT	1,104.5
TARE WEIGHT	
COAL WEIGHT	
VOLUME	
WET DENSITY	78.0

POINT NUMBER	Drop 2
1078	
1091	
1096	
1094	
1083	
1094	
1091	
1092	
1109	
1082	
1088	
1084	
1092	
1104	1223.5
1083	
AVERAGE	1,090.7
TOTAL WEIGHT	1,214.5
TARE WEIGHT	
COAL WEIGHT	
VOLUME	
WET DENSITY	89.7

POINT NUMBER	
863	
854	
870	
839	
844	
845	
857	
852	
860	
839	
841	
841	
854	
860	
856	
AVERAGE	851.7
TOTAL WEIGHT	1341.5
TARE WEIGHT	
COAL WEIGHT	
VOLUME	
WET DENSITY	103.2

POINT NUMBER	Bottom/Base
2107	
2145	
2139	
2136	
2113	
2137	
2159	
2145	
2155	
2118	
2162	
2117	
2149	
2138	873.0
2133	
AVERAGE	2136.9
TOTAL WEIGHT	864.0
TARE WEIGHT	
COAL WEIGHT	
VOLUME	
WET DENSITY	52.3

POINT NUMBER	
2086	
2074	
2046	
2073	
2075	
2084	
2090	
2068	
2088	
2085	
2091	
2077	
2057	
2080	902.5
2062	
AVERAGE	2075.7
TOTAL WEIGHT	893.5
TARE WEIGHT	
COAL WEIGHT	
VOLUME	
WET DENSITY	55.5

POINT NUMBER	
1942	
1961	
1959	
1980	
1954	
1934	
1947	
1959	
1970	
1961	
1942	
1949	
1956	
1960	951.0
1980	
AVERAGE	1956.9
TOTAL WEIGHT	942.0
TARE WEIGHT	
COAL WEIGHT	
VOLUME	
WET DENSITY	60.6

POINT NUMBER	
1796	
1785	
1773	
1789	
1801	
1775	
1790	
1782	
1768	
1793	
1811	
1802	
1799	
1784	
1779	
AVERAGE	1,787.1
TOTAL WEIGHT	1050.0
TARE WEIGHT	
COAL WEIGHT	
VOLUME	
WET DENSITY	72.2

MIKON CORPORATION Consulting Engineers
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CLIENT: SRP

PLANT: NAVAHO | STOCKPILE: ASH

DATE: 4-13-14 | PROBE NO.: 16 | PAGE: Cond 24 | OF:

DENSITY TESTING FIELD LOG

TEST HOLE NUMBER	DEPTH	SAMPLE NUMBER	BLOWS/ SPOON	SCALER READING	SCALER READING	REMARKS AND SOIL INTERFACE	STANDARD COUNT
AD-1	2.5-5	1	35	994			641
	12.5-15	2	15	1595			644
	22.5-25	3	40	865			650
	32.5-35	4	35	1352			676
	~~42.5-45~~	5				BASE=40'	
4-14-14							
AD-2	2.5-5	5	15	1496			652
	12.5-15	6	6	1689			661
	22.5-25	7	21	990			648
	32.5-35	8	10	1126			668
	42.5-45	9	28	917			668
	52.5-55	10	24	961			654
	~~62.5-65~~	11				BASE=63'	
AD-8	2.5-5	12	10	1058			680
	12.5-15	13	20	1049			672
	22.5-25	14	28	1302			659
	32.5-35	15	46	767			653
	42.5-45	16	M	1163			667
	52.5-55	17	50	1387			669
	62.5-66.5	18	38	1261			667
	72.5-75.5	19	106	1454			669
						BORING END @ 80'	

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CLIENT: SRP

PLANT: Navajo

STOCKPILE: AsL

DATE: 4-13 14-14

PROBE NO.

PAGE 16 OF Cord 24

DENSITY TESTING FIELD LOG

TEST HOLE NUMBER	DEPTH	SAMPLE NUMBER	BLOWS/ SPOON	SCALER READING	SCALER READING	REMARKS AND SOIL INTERFACE	STANDARD COUNT
AD-10	2.5-2.5	20	4	1164			660
	12.5 - 15	21	12	1336			663
	22.5 - 25	22	31	1273			666
	32.5 - 35	23	21	1406			653
	42.5 - 45	24	Drop	919			643
	52.5 - 55	25	DROP	1012			
*						BASE @ 59'	
4-15-14							
AD-4	2.5 - 5	26	19	1025			637
	12.5 - 15	27	28	1454			669
	22.5 - 25	28	21	1337			686
	32.5 - 35	29	36	1356			658
	42.5 - 45	30	48	989			663
	52.5 - 55	31	68	758			659
	62.5 - 65	32	120	810		Auger Refusal @ 70'	672
AD-7	2.5 - 5	33	18	1241			669
	12.5 - 15	34	22	1001			678
	22.5 - 25	35	14	1015			663
	32.5 - 35	36	39	1408		BASE 641'	659
	~~42.5 - 45~~	37					

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CLIENT: SRP

PLANT: Navajo | STOCKPILE: Ash

DATE: 04-15-14 | PROBE NO.: 16 | PAGE: 26 OF

DENSITY TESTING FIELD LOG

TEST HOLE NUMBER	DEPTH	SAMPLE NUMBER	BLOWS/ SPOON	SCALER READING	SCALER READING	REMARKS AND SOIL INTERFACE	STANDARD COUNT
AD-13	0.5-5	37	10	1105			647
	12.5-15	38	8	1813			659
	22.5-25	39	33	1638			644
	32.5-35	40	15	1412			667
	42.5-45	41	10	1093			668
	52.5-55	~~33~~ 42	33	1181			647
						BASE 62'	
AD-6	2.5-5	43	2	967			675
	12.5-15	44	26	958			665
	22.5-25	45	35	1497			659
	32.5-35	46	33	817			654
	42.5-45	47	70	988		LIME?	664
	52.5-55	48	165	850		HARD	
	62.5-65	49	157	871			660
	72.5-75	50	140	898		BORING REFUSAL @ 80'	
04-16-14							
AD-9	2.5-5	51	15	1454			636
	12.5-15	52	19	1149			662
	22.5-25	53	26	905			658
	32.5-35	54	29	1266			653
	42.5-45	55	88	861		LIME/ASH SLAG MIXTURE	658
	52.5-55	56	30	1134			647
	62.5-65	57	130	879		HARD	
	72.5-75	58	150	855		AUGER REFUSAL @ 80'	

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DATE: 04-16-14 | PROBE NO.: 16 | PAGE | OF

DENSITY TESTING FIELD LOG

TEST HOLE NUMBER	DEPTH	SAMPLE NUMBER	BLOWS/ SPOON	SCALER READING	SCALER READING	REMARKS AND SOIL INTERFACE	STANDARD COUNT
AD-12	2.5 - 5	59	2	1391	~~1721~~		658
	12.5 - 15	60	23	1721			661
	22.5 - 25	61	31	1028			658
	32.5 - 35	62	~~105~~	~~893~~ 938		MIX-HARD	655
	42.5 - 45	63	65			FLY ASH	662
	52.5 - 55	64	58	944		MIX - M. HARD	673
	62.5 - 65	65	100	893		MIX-HARD	661
	72.5 - 75	64	151	861			
AD-14	2.5 - 5	67	12	1771			673
	12.5 - 15	68	23	1000			683
	22.5 - 25	69	55	1430			680
	32.5 - 35	70	48	1252			676
	42.5 - 45	71	43	1356		WET MIX	670
	52.5 - 55	72	63	946		MIXED - MED.	668
	62.5 - 65	73	64	907		MIXED - HARD	658
	72.5 - 75	74	71	889		"	651
						AUGER REFUSAL @ 80	
AD-13	2.5 - 5	75	12	1134			647
	12.5 - 15	76	5	910			663
	22.5 - 25	77	34	1063			658
	32.5 - 35	78	22	960		FLY ASH MIX - SOFT	668
	42.5 - 45	79	121	872		MIX - HARD	
	52.5 - 55	80	143	841			
	62.5 - 65.	81	117	892		AUGER REFUSAL @ 71'	

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PLANT: Navajo | STOCKPILE: Ash

DATE: 04-17-14 | PROBE NO.: 16 | PAGE: Cnd 26 | OF:

DENSITY TESTING FIELD LOG

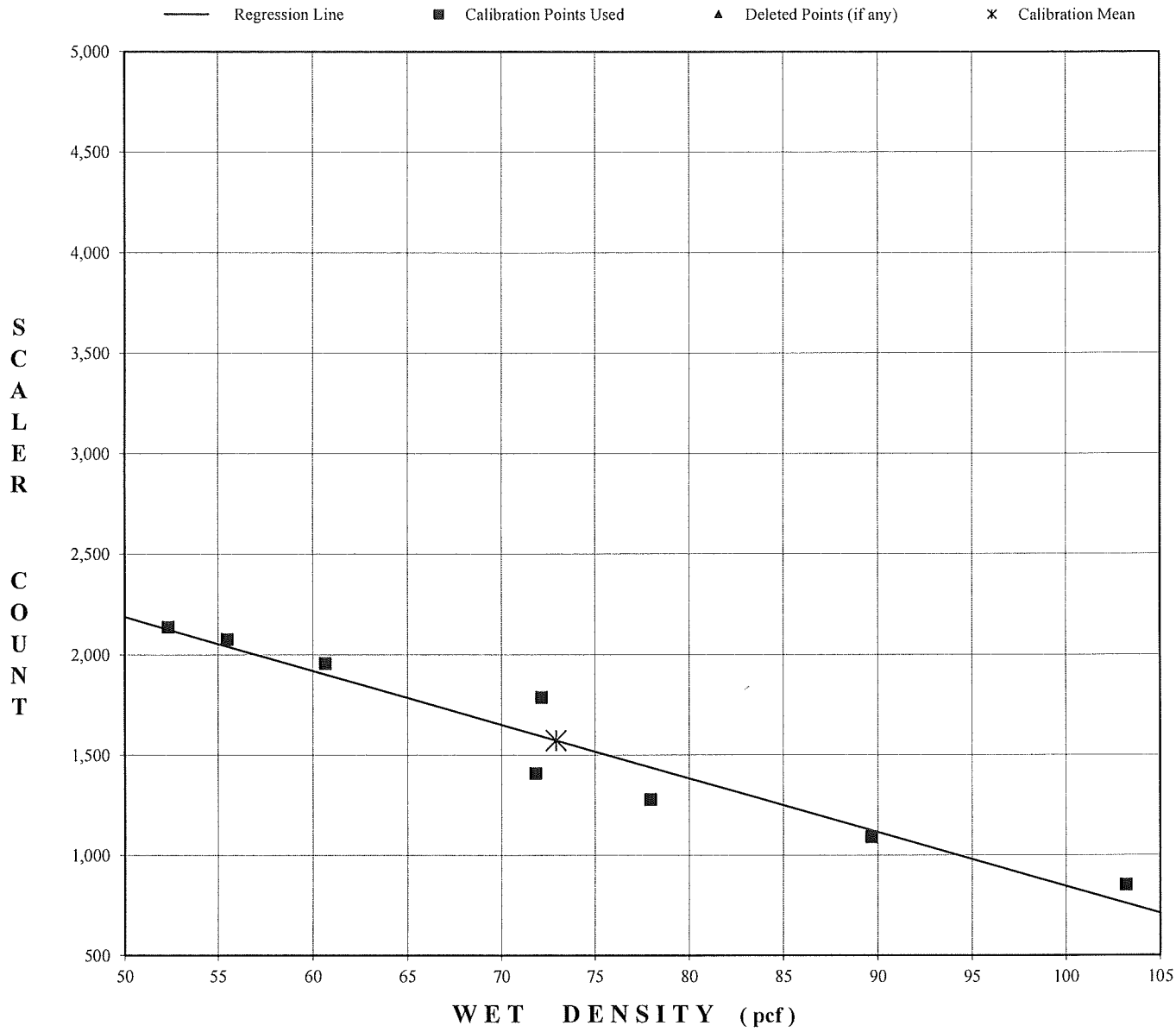
TEST HOLE NUMBER	DEPTH	SAMPLE NUMBER	BLOWS/ SPOON	SCALER READING	SCALER READING	REMARKS AND SOIL INTERFACE	STANDARD COUNT
AD-16	2.5 - 5	82	12	1595			645
	15.5 - 15	83	21	1113			665
	22.5 - 25	84	26	966			653
	32.5 - 35	85	4	963		FLY ASH - SOFT	658
	42.5 - 45	86	32	1500		~~FLY ASH - WET, SOFT~~ MIX - SOFT	665
	52.5 - 55	87	Drop	946		FLY ASH - SOFT MIX - DRY	660
	62.5 - 65	88	50	1145		MIX - SOFT MIX - DRY - MED	640
	72.5 - 75	89	83	898		MIX - HARD	
						BOB @ 80'	
AD-17	2.5 - 5	90	18	1581		MIX - SOFT	640
	12.5 - 15	91	22	1059		MIX - MED	662
	22.5 - 25	92	42	835		MIX - MED ~~FLY ASH - MED~~	668
	32.5 - 35	93	54	708		LAYERED FA/BA - HARD	653
	42.5 - 45	94	68	931		MIX - HARD LIME @ 45'	648
	52.5 - 55	95	105	982		MIX - HARD	660
	62.5 - 65	96	100	865		MIX HARD AUGER REFUSAL	
						@ 72'	

MIKON Corporation
St. Joseph, Missouri

NAVAJO GENERATING STATION

Date of Calibration
4/17/2014
Input by: BWD

GAUGE CALIBRATION # 2 — ASH



POINT NUMBER (#)	POINT USED ? (yes/no)	AVERAGE SCALER (count)	WET DENSITY (pcf)	OFFSET From Line (pcf)
1	YES	1,407.3	71.83	–7.24
2	YES	1,277.1	77.96	–5.97
3	YES	1,090.7	89.67	–1.19
4	YES	851.7	103.19	+3.44
5	YES	2,136.9	52.34	+0.43
6	YES	2,075.7	55.48	+1.29
7	YES	1,956.9	60.65	+2.04
8	YES	1,787.1	72.15	+7.22

REGRESSION LINE PARAMETERS

SLOPE = -26.8618
INTERCEPT = 3,531.3846
CORR. COEFF. (R^2) = 0.9296 (†)

(†) According to ASTM D 6347, A4.6,
R^2 is expected to exceed 0.9500
for most calibrations.

MEAN OF CALIBRATION POINTS

WET DENSITY (pcf) = 72.9088
SCALER COUNT = 1,572.9250

[NAVAJO C 04_14]
4/21/2014 3:51 PM

DATA SUMMARY
NAVAJO STATION
ASH STOCKPILE

TEST LOCATION	DEPTH (FT)	TEST ELEV.	SCALER COUNT	WET DENSITY (PCF)	MOIST. CONTENT (%)	DRY DENSITY (PCF)
AD1	5.0	-5.0	994	94.5	-	-
	15.0	-15.0	1595	72.1	-	-
	25.0	-25.0	865	99.3	-	-
	35.0	-35.0	1352	81.1	-	-
			AVERAGE	86.7	-	-
AD2	5.0	-5.0	1496	75.8	-	-
	15.0	-15.0	1689	68.6	-	-
	25.0	-25.0	990	94.6	-	-
	35.0	-35.0	1126	89.5	-	-
	45.0	-45.0	917	97.3	-	-
	55.0	-55.0	961	95.7	-	-
			AVERAGE	86.9	-	-
AD4	5.0	-5.0	1025	93.3	-	-
	15.0	-15.0	1454	77.3	-	-
	25.0	-25.0	1337	81.7	-	-
	35.0	-35.0	1356	81.0	-	-
	45.0	-45.0	989	94.6	-	-
	55.0	-55.0	758	103.2	-	-
	65.0	-65.0	810	101.3	-	-
			AVERAGE	90.4	-	-

(*) = RESULT NOT USED IN AVERAGING.

DATA SUMMARY
NAVAJO STATION
ASH STOCKPILE

TEST LOCATION	DEPTH (FT)	TEST ELEV.	SCALER COUNT	WET DENSITY (PCF)	MOIST. CONTENT (%)	DRY DENSITY (PCF)
AD6	5.0	-5.0	967	95.5	-	-
	15.0	-15.0	958	95.8	-	-
	25.0	-25.0	1497	75.7	-	-
	35.0	-35.0	817	101.1	-	-
	45.0	-45.0	988	94.7	-	-
	55.0	-55.0	850	99.8	-	-
	65.0	-65.0	871	99.0	-	-
	75.0	-75.0	898	98.0	-	-
			AVERAGE	95.0	-	-
AD7	5.0	-5.0	1241	85.3	-	-
	15.0	-15.0	1001	94.2	-	-
	25.0	-25.0	1015	93.7	-	-
	35.0	-35.0	1408	79.0	-	-
			AVERAGE	88.0	-	-
AD8	5.0	-5.0	1058	92.1	-	-
	15.0	-15.0	1049	92.4	-	-
	25.0	-25.0	1302	83.0	-	-
	35.0	-35.0	767	102.9	-	-
	45.0	-45.0	1163	88.2	-	-
	55.0	-55.0	1387	79.8	-	-
	65.0	-65.0	1261	84.5	-	-
	75.0	-75.0	1454	77.3	-	-
			AVERAGE	87.5	-	-

(*) = RESULT NOT USED IN AVERAGING.

DATA SUMMARY
NAVAJO STATION
ASH STOCKPILE

TEST LOCATION	DEPTH (FT)	TEST ELEV.	SCALER COUNT	WET DENSITY (PCF)	MOIST. CONTENT (%)	DRY DENSITY (PCF)
AD9	5.0	-5.0	1454	77.3	-	-
	15.0	-15.0	1149	88.7	-	-
	25.0	-25.0	905	97.8	-	-
	35.0	-35.0	1266	84.3	-	-
	45.0	-45.0	861	99.4	-	-
	55.0	-55.0	1134	89.2	-	-
	65.0	-65.0	879	98.7	-	-
	75.0	-75.0	855	99.6	-	-
			AVERAGE	91.9	-	-
AD10	5.0	-5.0	1164	88.1	-	-
	15.0	-15.0	1336	81.7	-	-
	25.0	-25.0	1273	84.1	-	-
	35.0	-35.0	1406	79.1	-	-
	45.0	-45.0	919	97.3	-	-
	55.0	-55.0	1012	93.8	-	-
			AVERAGE	87.4	-	-

(*) = RESULT NOT USED IN AVERAGING.

DATA SUMMARY
NAVAJO STATION
ASH STOCKPILE

TEST LOCATION	DEPTH (FT)	TEST ELEV.	SCALER COUNT	WET DENSITY (PCF)	MOIST. CONTENT (%)	DRY DENSITY (PCF)
AD12	5.0	-5.0	1391	79.7	-	-
	15.0	-15.0	1721	67.4	-	-
	25.0	-25.0	1028	93.2	-	-
	35.0	-35.0	893	98.2	-	-
	45.0	-45.0	938	96.5	-	-
	55.0	-55.0	944	96.3	-	-
	65.0	-65.0	893	98.2	-	-
	75.0	-75.0	861	99.4	-	-
			AVERAGE	91.1	-	-
AD13	5.0	-5.0	1105	90.3	-	-
	15.0	-15.0	1813	64.0	-	-
	25.0	-25.0	1638	70.5	-	-
	35.0	-35.0	1412	78.9	-	-
	45.0	-45.0	1093	90.8	-	-
	55.0	-55.0	1181	87.5	-	-
			AVERAGE	80.3	-	-

(*) = RESULT NOT USED IN AVERAGING.

DATA SUMMARY
NAVAJO STATION
ASH STOCKPILE

TEST LOCATION	DEPTH (FT)	TEST ELEV.	SCALER COUNT	WET DENSITY (PCF)	MOIST. CONTENT (%)	DRY DENSITY (PCF)
AD14	5.0	-5.0	1777	65.3	-	-
	15.0	-15.0	1000	94.2	-	-
	25.0	-25.0	1430	78.2	-	-
	35.0	-35.0	1252	84.9	-	-
	45.0	-45.0	1356	81.0	-	-
	55.0	-55.0	946	96.2	-	-
	65.0	-65.0	907	97.7	-	-
	75.0	-75.0	889	98.4	-	-
			AVERAGE	87.0	-	-
AD15	5.0	-5.0	1134	89.2	-	-
	15.0	-15.0	910	97.6	-	-
	25.0	-25.0	1063	91.9	-	-
	35.0	-35.0	960	95.7	-	-
	45.0	-45.0	872	99.0	-	-
	55.0	-55.0	861	99.4	-	-
	65.0	-65.0	892	98.3	-	-
			AVERAGE	95.9	-	-

(*) = RESULT NOT USED IN AVERAGING.

DATA SUMMARY
NAVAJO STATION
ASH STOCKPILE

TEST LOCATION	DEPTH (FT)	TEST ELEV.	SCALER COUNT	WET DENSITY (PCF)	MOIST. CONTENT (%)	DRY DENSITY (PCF)
AD16	5.0	-5.0	1595	72.1	-	-
	15.0	-15.0	1113	90.0	-	-
	25.0	-25.0	966	95.5	-	-
	35.0	-35.0	963	95.6	-	-
	45.0	-45.0	1500	75.6	-	-
	55.0	-55.0	946	96.2	-	-
	65.0	-65.0	1145	88.8	-	-
	75.0	-75.0	898	98.0	-	-
			AVERAGE	89.0	-	-
AD17	5.0	-5.0	1581	72.6	-	-
	15.0	-15.0	1059	92.0	-	-
	25.0	-25.0	835	100.4	-	-
	35.0	-35.0	708	105.1	-	-
	45.0	-45.0	931	96.8	-	-
	55.0	-55.0	882	98.6	-	-
	65.0	-65.0	865	99.3	-	-
			AVERAGE	95.0	-	-

STOCKPILE TOTALS:

STOCKPILE AVERAGE	89.8	-	-
STANDARD DEVIATION	9.8	-	-
TOTAL TESTS	95	0	0
TESTS USED	95	0	0

(*) = RESULT NOT USED IN AVERAGING.