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0000032478

APS

A subsidiary of Pinnacle West Capital Corporation

Justin H. Thompson
Manager
Regulation, Policy & Analysis

Tel. 602-250-2060
Fax 602-250-3003
e-mail Justin.Thompson@aps.com

Mail Station 9708
PO Box 53999
Phoenix, Arizona 85072-3999

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October 7, 2005

Docket Control
Arizona Corporation Commission
1200 West Washington
Phoenix AZ 85007

Re: Docket No. E-01345A-03-0437
Reliability Review of Electric Service to Tribal Territories

Dear Sir/Madame:

Pursuant to Decision No. 67744, Section u, page 34, Arizona Public Service Company (APS) hereby files the CAIDI, SAIDI & SAIFI numbers for all Tribal territories and the report on proposed options for improving reliability of electric service to Tribal territories.

If you have any questions, please feel free to call me.

Sincerely,

Justin Thompson
Manager
Regulation, Policy and Analysis

JHT/jav

CC: Docket Control
Brian Bozzo, Compliance and Enforcement

ARIZONA PUBLIC SERVICE COMPANY

RELIABILITY REVIEW OF ELECTRIC SERVICE TO TRIBAL TERRITORIES

OCTOBER 5, 2005

TABLE OF CONTENTS

EXECUTIVE SUMMARY **1**

ANALYSIS **3**

MAINTENANCE PROGRAMS 3
RELIABILITY RESULTS 4
RELIABILITY THRESHOLD 5
FEEDER ANALYSIS 6
Bear Springs feeder #1 ..... *7*
Cameron feeder #1 ..... *7*
Cameron feeder #3 ..... *8*
Caywood feeder #1 ..... *8*
Cement – Verde 69kV line *8*
Cocopah feeder #1 ..... *9*
Copper Canyon Feeder #2 ..... *9*
Cottonwood Feeder #22 ..... *9*
Gila Bend feeder #22 ..... *9*
Gray Mountain feeder #1 ..... *10*
Hamblin feeder #1 ..... *10*
Hayfield Draw feeder #2 ..... *11*
Keams Canyon feeder #3 ..... *11*
Keams Canyon feeder #5 ..... *11*
Laguna feeder #1 ..... *12*
Laguna feeder #5 ..... *12*
McGuireville feeder #10 ..... *12*
McGuireville feeder #14 ..... *13*
Mitry Feeder #1 ..... *13*
Papago feeder #9 ..... *13*
Papago feeder #11 ..... *13*
Pinal feeder #1 ..... *14*
Prescott City feeder #3 ..... *14*
Sundog feeder #5 ..... *14*
Sunshine feeder #1 ..... *14*
Thirty-Second Street feeder #1 ..... *15*
Tonalea feeder #1 ..... *15*
Tonto feeder #4 ..... *15*
Tuba City feeder #1 ..... *16*
Tuba City feeder #3 ..... *16*
Valley Farms feeder #6 ..... *16*
Vista feeder #6 ..... *17*
Why feeder #1 ..... *17*
IMPACT OF TRANSMISSION ON RELIABILITY 17
CONCLUSION 18
REFERENCES 19
ATTACHMENT 1 – SUMMARY OF RELIABILITY WITHIN TRIBAL TERRITORIES 20
ATTACHMENT 2 – MAP OF TRIBAL TERRITORIES WITHIN ARIZONA 21

APPENDIX A - FEEDER MAPS FOR APS FACILITIES SERVING TRIBAL TERRITORIES **22**

RELIABILITY REVIEW OF ELECTRIC SERVICE TO TRIBAL TERRITORIES

EXECUTIVE SUMMARY

In Decision No. 67744 (April 7, 2005), the Arizona Corporation Commission ("Commission") ordered:

> *IT IS FURTHER ORDERED that within six months of the effective date of this Decision, Arizona Public Service Company shall compile its SAIFI, CAIDI and SAIDI numbers for all Tribal territories it serves and provide the Commission a report on proposed options for improving reliability in these areas, and Arizona Public Service Company shall participate in any future dockets related to enhancing reliability statewide.*

All feeders[1] serving load within tribal territories[2] were analyzed in this report. A performance summary of each of the thirty-three feeder's serving load within tribal territories has been tabulated by tribe, and is included as Attachment 1. A map of known tribal territories in Arizona also provided as Attachment 2.

Overall, the reliability of APS' service to tribal territories is good. A benchmark threshold was established, based on the Company's internal performance data and IEEE guidelines. Nearly three-fourths of the thirty-three feeders serving tribal territories have reliability indices that are outperforming the established reliability thresholds. Further, the combined average SAIFI, SAIDI, and CAIDI[3] indices of all feeders serving tribal territories is within ±10% of the State Division[4] reliability targets for 2004.

Service reliability may be challenged however, in some cases by the lengthy transmission lines needed to serve load. The analysis notes that transmission reliability plays a large part in distribution reliability in rural areas. Of the nine feeders identified as having a reliability indicator over the reliability threshold, six were due to transmission related causes.

The benchmarking data provided confirms that overall, APS' transmission reliability compares favorably with the industry. In addition, the Company has demonstrated a positive 5-year performance trend for all transmission voltage levels; and that the subject transmission lines are in compliance with NERC and WECC requirements. The report notes that the transmission lines serving the six feeders referenced above are some of the longest in the Company's system (1st, 2nd, and 7th) and, as Commission Staff and EPRI have

[1] Feeders are the electrical facilities between a distribution substation and a customers' transformer. Feeders typically include overhead and underground wire, protective devices such as fuses and reclosers, voltage control devices such as voltage regulators and capacitor banks, and distribution transformers.

[2] Load within the tribal boundary may be tribal or non-tribal; e.g. a natural gas pipeline compressor station. The tribal boundaries were developed from Graphical Information System data obtained from the US Census Bureau.

[3] SAIFI or System Average Interruption Frequency Index is defined as the total number of customers interrupted divided by the total customer base; SAIDI or System Average Interruption Duration Index is the total outage duration time seen by customers divided by the total customer base; and CAIDI or Customer Average Interruption Duration Index is defined as the total outage duration time seen by customers divided by the total number of customers experiencing an outage.

[4] State Division is the service territories outside of the metropolitan Phoenix area. Total tribal territory SAIFI is approximately 10% higher than the State target, SAIDI is 7% higher, and CAIDI is 10% lower.

indicated, transmission line length does play an important role in distribution performance.

During the Company's recent rate case, the Commission Staff performed a reliability review of APS' service and noted: "It is normal to expect such rural services to experience a greater number of service interruptions of longer duration due to: 1) longer length distribution feeders with aging distribution equipment due to slower growth patterns, 2) limited feeder switching capability among distribution substations, 3) remoteness of limited service personnel, and 4) geographic areas in which storm disturbances are more prominent."[5]

This overall reliability limitation has been echoed by the Electric Power Research Institute (EPRI) in *Distribution Reliability Indices Tracking Within the United States*, 2003:

> Service territories generally include urban, suburban, or rural, or more likely, some combination of all of these. Distribution systems designed for rural areas are generally made up of smaller substations with long radial circuits extending for many miles with little redundancy and few circuit ties. In contrast, systems in dense urban areas often deploy grid like systems and incorporate larger substations often with redundant facilities, shorter circuit lengths, and multiple feeds.
>
> Circuit distance alone is a substantial reliability issue; longer circuits have inherently more interruptions. This is due to the fact that more circuit length equates to more exposure and more potential points of failure.

Overall, APS' reliability record is strong. In the most recent Edison Electric Institute distribution reliability ranking the Company ranked in the first or second quartile for SAIFI, SAIDI, and CAIDI, and has reduced interruptions per customer by 42% and customer interruption duration by 47% since 1996. APS places a high priority on service to its customers as evidenced by continuous improvement in the Company's J. D. Powers Reliability and Power Quality scores. Since 2001, APS has exceeded both the industry and Western Regional averages among residential customers, and has exceeded the industry and Western region averages among business customers since 2003 (the beginning year for this indicator). Moreover, Commission Staff's review of APS' reliability achievements concluded that "APS is managing its entire distribution system on a par with the better utilities in the nation."[6]

This report briefly describes the maintenance programs and projects that the Company implements with respect to its entire transmission, substation, and distribution systems. All facilities are treated equally within the Company's maintenance program; i.e., rural facilities (including those on tribal territories) receive the same attention as those facilities within the urban centers.

In the analysis, a number of attributes were considered to determine the need for service improvement on any specific feeder including comparison to system norms, recent facility maintenance activities, planned upgrades, and planned facility additions. Those feeders exceeding established reliability thresholds were further investigated to determine the cause and develop corrective actions. A summary of corrective action activities is included in the Conclusion.

[5] ACC Engineering Report Analyzing Quality Of Service Matters Related To The Arizona Public Service Company Rate Case Application, Docket No. E-01345A-03-0437, May 14, 2004, p. 8

[6] Ibid., p. 11.

ANALYSIS

In Decision No. 67744 (April 7, 2005), the Arizona Corporation Commission ("Commission"), ordered:

> *IT IS FURTHER ORDERED that within six months of the effective date of this Decision, Arizona Public Service Company shall compile its SAIFI, CAIDI and SAIDI numbers for all Tribal territories it serves and provide the Commission a report on proposed options for improving reliability in these areas, and Arizona Public Service Company shall participate in any future dockets related to enhancing reliability statewide.*

As a result, APS Transmission and Distribution Reliability Analysis and Management compiled SAIFI, CAIDI, and SAIDI data for feeders known to be serving Tribal territories. System Average Interruption Frequency Index (SAIFI) is defined as the total number of customers interrupted divided by the total customer base; Customer Average Interruption Duration Index (CAIDI) is defined as the total outage duration time seen by customers divided by the total number of customers experiencing an outage; and System Average Interruption Duration Index (SAIDI) is the total outage duration time seen by customers divided by the total customer base. All three indicators are defined in IEEE Standard 1366-2003, *IEEE Guide for Electric Power Distribution Reliability Indices.*

The feeders and lines analyzed are as follows:

> Bear Springs feeder #1, Cameron feeders #1 and #3, Caywood feeder #1, the Cement to Verde 69kV transmission line, Cocopah feeder #1, Copper Canyon feeder #2, Cottonwood feeder #22, Gila Bend feeder #22, Gray Mountain feeder #1, Hamblin feeder #1, Hayfield Draw feeder #2, Keams Canyon feeders #3 and #5, Laguna feeders #1 and #5, Mitry feeder #1, McGuireville feeders #10 and #14, Papago feeders #9 and #11, Pinal feeder #1, Prescott City feeder #3, Sundog feeder #5, Sunshine feeder #1, Thirty-Second Street feeder #1, Tonalea feeder #1, Tonto feeder #4, Tuba City feeders #1 and #3, Valley Farms feeder #6, Vista feeder #6, and Why feeder #1.

All distribution reliability data provided in this report is, unless otherwise noted, calculated per IEEE 1366-2003, *IEEE Guide for Electric Power Distribution Reliability Indices,* except that the threshold for a sustained outage utilizes APS' more stringent internal 1 minute threshold instead of than IEEE's 5 minute threshold.[7]

MAINTENANCE PROGRAMS

Reliability is a focal point of APS' maintenance efforts and has been for nearly a decade. APS annually performs about 30 programs or projects to maintain or improve reliability throughout the Company's entire transmission, substation, and distribution systems. All facilities are treated equally within the Company's maintenance program; i.e., rural facilities (including those on tribal territories) receive the same attention as those facilities within urban centers. All maintenance performed by the Company will affect feeder performance, even if the

[7] APS has used the Company's internal one minute threshold in this analysis, instead of the IEEE five minute threshold, for accuracy of data analysis. Normal Company record keeping is to the one minute threshold. Although data could be converted to the five minute threshold, the task is not trivial. The results however, are not expected to be substantially different company-wide. It is expected that the performance of feeders serving tribal territory would improve relative to the total company since, as will be shown in the analysis portion of this report, much of the performance is tied to the performance of the transmission system. Typically, transmission outages are less than five minutes, yet longer than one minute. Thus, many outages currently tracked on feeders serving tribal territories would be excluded. Further, IEEE 1366 "Major Event Day" data was not excluded segmented from the data. Therefore, APS is conservative in its approach.

maintenance is performed within a substation or on a transmission line. As examples, the blackouts of August 11, 1996 in the west and August 13, 2003 in the east were both caused, in part, by vegetation contact with high voltage power lines.

Transmission, substation, and distribution maintenance programs performed by APS include maintenance of transformers, circuit breakers, and relays in substations, thermographic inspection of equipment, and patrols and repairs of transmission and distribution lines. Efforts such as adding wildlife protection guards to substation and distribution equipment not only accomplish their primary purpose of protecting wildlife, but also help to eliminate outages.

APS performs annual public safety patrols of the Company's transmission and distribution lines. Although these patrols are primarily focused on ensuring facilities do not present a hazard to the public, other items identified as potential problems are noted for maintenance or replacement. APS transmission lines get a full climbing inspection every seven to ten years, depending on construction type and a ground-line wood pole inspection is performed to determine if the poles are healthy or require repair or replacement.

Each year, at the distribution level, the Company identifies eight to ten distribution feeders that show the greatest decline in performance over a three year period. APS then patrols those facilities with dedicated reliability crews, for additional inspection and corrective actions. Wood pole inspections are performed to determine if the poles are healthy or require repair or replacement. In addition, defective surge arresters may be replaced, structural hardware is tightened, and additional protective devices, such as fuses or reclosers, may be installed.

Since 2003, APS has also reworked pole grounds and installed lightning arresters to selected feeders in the southern part of the state and parts of the Mogollon Rim area. Although Arizona has only a fraction of the lightning experienced in the Southeastern United States, in pockets of the state lightning related outages are becoming a larger percentage of our outages as our overall outage performance improves.

RELIABILITY RESULTS

The impact of the above described maintenance has been dramatic. APS' combined reliability programs are yielding great dividends. Since 1996, when a dedicated reliability management team was established, the annual per customer interruption rate has dropped by 42% and the annual per customer interruption duration has dropped by 47%.

By 2002, APS attained best performance quartile, among the nearly 60 utilities benchmarking their reliability data through the Edison Electric Institute [1], for annual per customer interruption rate and annual per customer interruption duration.

Through our maintenance efforts, APS' reliability places it favorably among our industry peers. In APS' most recent independent reliability assessment [2], EPRI Solutions stated that:

> the reliability indices indicate a level of effectiveness, performance and reliability at APS that exceeds the level of effectiveness, performance and reliability considered industry Standard Effectiveness and Standard Performance within the WECC as demonstrated by the EEI benchmarking study as well as this investigation.

Similarly, the ACC staff reviewed APS' reliability efforts during the last rate case. The ACC's review of APS' reliability achievements concluded that "APS is managing its entire distribution system on a par with the better utilities in the nation."[8]

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[8] ACC Engineering Report Analyzing Quality Of Service Matters Related To The Arizona Public Service Company Rate Case Application, Docket No. E-01345a-03-0437, May 14, 2004, p. 11

This strong reliability performance has also been noted through our customers' response in recent J. D. Powers' Reliability and Power Quality surveys. Since 2001, APS has exceeded the industry and Western Region averages among residential customers, and has exceeded the industry and Western region averages among business customers since 2003 (the beginning year for this indicator).

RELIABILITY THRESHOLD

To analyze "proposed options to improve reliability" as stated in Decision No. 67744, it is important to first establish whether reliability is an issue on a specific feeder and, if so, what the specific issues are related to its reliability. To accomplish this, APS derived norms by which acceptable performance could be judged.

Common sense would suggest and experience has shown that a long, overhead distribution feeder, originating from a substation at the end of a long 69kV transmission line (such as with Keams Canyon feeder #3) will be less reliable than a short, underground feeder which has multiple 69kV or 230kV sources.

The ACC's reliability review, during the most recent rate case, noted: "It is normal to expect such rural services to experience a greater number of service interruptions of longer duration due to: 1) longer length distribution feeders with aging distribution equipment due to slower growth patterns, 2) limited feeder switching capability among distribution substations, 3) remoteness of limited service personnel, and 4) geographic areas in which storm disturbances are more prominent."[9]

This overall reliability limitation has been echoed by the Electric Power Research Institute (EPRI) in *Distribution Reliability Indices Tracking Within the United States*, 2003:

> Service territories generally include urban, suburban, or rural, or more likely, some combination of all of these. Distribution systems designed for rural areas are generally made up of smaller substations with long radial circuits extending for many miles with little redundancy and few circuit ties. In contrast, systems in dense urban areas often deploy grid like systems and incorporate larger substations often with redundant facilities, shorter circuit lengths, and multiple feeds.
>
> Circuit distance alone is a substantial reliability issue; longer circuits have inherently more interruptions. This is due to the fact that more circuit length equates to more exposure and more potential points of failure.

While it has been observed that: 1) overhead distribution feeders have inherently higher outage frequencies and shorter outage duration than underground distribution feeders; and 2) that distribution feeders with a single transmission source are more susceptible to outages and have a longer outage duration than distribution feeders with multiple transmission sources, there is no industry study that quantifies the effects of these different configurations from a statistical perspective.

However, some guidance is available. IEEE Standard 1366-2003, *IEEE Guide for Electric Power Distribution Reliability Indices,* Section 4.5, Major event day classification, introduced the 2.5β method for use in establishing "Major Event Days" for utilities' reliability data. APS participated in the development of IEEE 1366 as a member of the *Working Group on System Design* of the *Transmission and Distribution Committee* of the *IEEE Power Engineering Society*; the authors of the guideline. Further, APS submitted data to the Working Group and helped prove that the nature of SAIDI/day data is a lognormal distribution. The "2.5β Method" refers to the

[9] ACC Engineering Report Analyzing Quality Of Service Matters Related To The Arizona Public Service Company Rate Case Application, Docket No. E-01345a-03-0437, May 14, 2004, p. 8

mean plus 2 ½ times the standard deviation of the data and establishes a threshold for data segregation. The method is utilized in analyzing SAIDI statistics, but the Guideline goes on to state that "Even though SAIDI is used to determine the major event days, all indices should be calculated based on removal of the identified days."

The lognormal distribution is commonly used for general reliability analysis, cycles-to-failure in material strengths, and loading variables in probabilistic design. Another advantage of the log-normal distribution is that it is positive-definite, so it is useful for representing quantities that cannot have negative values, such as SAIFI, SAIDI, and CAIDI values. Many practitioners maintain that the lognormal distribution is as fundamental as the normal distribution thus the lognormal distribution has found applications in fields including the physical sciences, life sciences, social sciences, and engineering fields. The log-normal distribution is appropriate to distribution reliability data and has been used in several reliability applications [3] and [4].

In general terms, a lognormal distribution is exemplified by data highly shifted toward the low end of the x-axis, has a sharp peak, and has a long tail toward the high end of the x-axis. A random variable is lognormally distributed if the logarithm of the random variable is normally distributed (a bell curve). If a sample of data is determined to come from a lognormally distributed population, the geometric mean and the geometric standard deviation may be used to estimate confidence intervals akin to the way the arithmetic mean and standard deviation are used to estimate confidence intervals for a normally distributed sample of data.

An analysis of 2002 – 2004 distribution reliability data, utilizing IEEE 1366 and APS' more stringent one minute threshold for sustained outages, was performed for the entire APS system utilizing two attributes that best classify the performance behavior of rural vs. urban feeders: single transmission source vs. redundant transmission source and overhead vs. underground distribution construction. The analysis was performed to establish the mean and standard deviation for SAIFI, SAIDI and CAIDI. To be conservative, one standard deviation above the mean has been used as the reliability threshold, as compared with 2 ½ standard deviations above the mean for establishment of IEEE 1366 "Major Event Day". The analysis notes that SAIFI, SAIDI, and CAIDI are very strongly influenced by both characteristics; as one would expect.

The analysis establishes the following SAIFI, SAIDI, and CAIDI reliability thresholds for the entire APS system:

Reliability Threshold

	Single Trans-mission	Redundant Trans-mission	Over-head Distri-bution	Under-ground Distri-bution
SAIFI	6.77	3.03	6.40	2.40
SAIDI (Min)	567.1	189.6	572.1	128.6
CAIDI (Min)	175.4	147.9	126.2	190.0

FEEDER ANALYSIS

Each feeder has been evaluated using the applicable configuration attributes. A detailed feeder by feeder analysis was performed to determine whether any feeders or lines had specific reliability issues when the 2002-2004 averaged data was compared to the reliability threshold. Average SAIFI, SAIDI, and CAIDI values are shaded in yellow if both reliability thresholds are not met. For those feeders where the reliability threshold has been exceeded, the cause will be discussed, as well as previous projects and proposed options to improve service.

Attachment #1 contains the three year (2002 – 2004) compilation of SAIFI, SAIDI, and CAIDI statistics for each subject feeder or line providing service within tribal territory. Data has been compiled in accordance with IEEE 1366 with the exception that 'Major Event Day" data has not been segmented and

remains included in the accompanying data, and the sustained/momentary threshold used is the more stringent APS internal one minute rather than IEEE's five minutes.

BEAR SPRINGS FEEDER #1

Bear Springs feeder #1 serves one customer north of Cameron and west of Highway 89. The customer is within the Navajo Nation. The feeder is 100% overhead and is approximately two miles in length. The Bear Springs substation has a single transmission source from the Black Mesa – Tuba City line, which also has a single transmission source from the Black Mesa – Sandvig line. The two lines total approximately one-hundred twenty-nine miles in length.[10]

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	7.00	2.00	9.00	6.00
SAIDI (Min)	540.0	120.0	60.0	240.0
CAIDI (Min)	77.1	60.0	6.7	47.9

The above reliability is better than the established reliability threshold.

Reliability improvements discussed under Cameron feeder #1 and Tuba City feeder #1 will also benefit this feeder.

CAMERON FEEDER #1

Cameron feeder #1 serves 104 customers in Cameron on the west side of Highway 89. All customers are within the Navajo Nation. The feeder is 85% overhead and is approximately one mile in length. The Cameron substation has a single transmission source from the Black Mesa – Tuba City line, which is also radially fed by the Black Mesa – Sandvig line. Both lines total approximately one-hundred twenty-nine miles in length[11].

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	8.00	2.95	9.17	6.71
SAIDI (Min)	581.0	901.2	260.4	580.9
CAIDI (Min)	72.6	305.3	28.4	135.4

The SAIDI average for Cameron feeder #1 is above the APS reliability threshold for overhead feeders with a single transmission source. The major cause of the high SAIDI was a single 9 hour 53 minute outage in 2003. APS' Outage Log reports that after sectionalizing, a pole burnt in two between crossarms was found during the patrol. The Log also notes that the pole was in a canyon. Although some load was restored from Powell substation, because the fault was between Black Mesa and Cameron, the remaining load could not be restored until the pole was replaced. Absent this single event, all reliability thresholds would have been met.

The Black Mesa – Sandvig and Black Mesa – Tuba City 69kV lines were "climbing inspected"; i.e., check tightness of hardware, in 2005 and had the condition of its wood poles inspected in 2004. Any pole deemed to be under strength, or that was expected to be under strength within ten years, was repaired or replaced.

To improve restoration time, which reduces SAIDI, a reliable second transmission source is required to the Tuba City area. The limiting factor to carrying load south of the City of Powell from Powell Substation to the Tuba City area is ensuring adequate voltage at all distribution substations served by the line. APS will be installing capacitor banks at the Tuba City substation in 2006, to improve voltage on the Black Mesa – Tuba City line.

[10] This line mileage include the length of the Black Mesa – Tuba City line from the Tuba City tap up to Powell substation, as the normal open point (Switch 69J2739) is at Powell substation

[11] Ibid.

These capacitors will also improve voltage when the load is fed from Powell Substation. In addition, APS has been in negotiations with WAPA to replace the existing manual switch at Powell Substation with a circuit breaker. The contract is expected to be signed by the end of the year. Further, APS will be automating switches in 2006 at strategic location on the Black Mesa – Tuba City line and Black Mesa – Sandvig line which will improve switching time during fault location efforts.

Because the Black Mesa – Tuba City and Black Mesa – Sandvig lines also serves Bear Springs feeder #1, Cameron feeder #3, Gray Mountain feeder #1, Hamblin feeder #1, Tuba City feeder #1 and #3, and Tonalea feeder #1, these improvements will also benefit customers on those feeders. Further, as will be discussed under Tuba City #1 feeder, efforts are underway to address transmission caused SAIFI concerns, which will again benefit all of the above feeders.

CAMERON FEEDER #3

Cameron feeder #3 serves 107 customers south of Cameron to north of the Moenkopi switchyard. All customers are within the Navajo Nation. The feeder is 95% overhead and is approximately six miles in length. The Cameron substation has a single transmission source from the Black Mesa – Tuba City line, which also has a single transmission source from the Black Mesa – Sandvig line. The two lines total approximately one-hundred twenty-nine miles in length[12].

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	7.04	2.01	9.00	6.02
SAIDI (Min)	500.2	639.6	224.2	454.7
CAIDI (Min)	71.1	318.3	24.9	138.1

[12] Ibid., p. 5.

The above reliability is better than the established reliability threshold.

Reliability improvements discussed under Cameron feeder #1 and Tuba City feeder #1 will also benefit this feeder.

CAYWOOD FEEDER #1

Caywood feeder #1 serves approximately 30 customers between Beggs Road, Bianco Road, Anderson Road, and the Tohono O'Odham Nation, and is partially owned by Electrical District 3. The feeder serves 1 customer on the Tohono O'Odham Nation. The feeder is predominately overhead and is approximately 16 miles in length. The Caywood substation has a single transmission source from the Maricopa (DOE) – Sexton line, which is approximately twenty-two miles in length.

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	6.17	2.00	1.13	3.10
SAIDI (Min)	358.0	156.0	350.0	288.0
CAIDI (Min)	58.1	78.0	308.8	148.3

The above reliability is better than the established reliability threshold.

CEMENT – VERDE 69KV LINE

The Cement – Verde 69kV line serves one customer at 69kV on the Salt River Pima Indian Reservation. It is a single, overhead feed from Verde Substation to the Phoenix Cement Plant and is approximately seven miles in length.

Reliability data for the line is as follows:

	2002	2003	2004	Avg.
SAIFI	0.00	0.00	0.00	0.00
SAIDI (Min)	0.0	0.0	0.0	0.0
CAIDI (Min)	0.0	0.0	0.0	0.0

The above reliability is better than the established reliability threshold.

COCOPAH FEEDER #1

Cocopah feeder #1 serves 1,478 customers between the Colorado River, County 8 ½, and Avenue C. The feeder serves 36 customers and an RV park within the North Cocopah Indian Reservation. The feeder is 65% overhead and is approximately thirteen miles in length. The Cocopah substation is redundantly fed from the Cocopah – Tenth Street line and the Cocopah – Yucca line, which are five and four miles respectively.

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	0.06	6.86	5.19	4.04
SAIDI (Min)	5.9	557.1	216.4	259.8
CAIDI (Min)	92.2	81.2	41.7	71.7

The above reliability is better than the established reliability threshold.

COPPER CANYON FEEDER #2

Copper Canyon feeder #2 serves approximately 1,400 customers in Middle Verde. The feeder serves 27 customers on the Yavapai – Apache Nation. The feeder is 64% overhead and is approximately six miles in length. The Copper Canyon substation has a single transmission source from the Childs – Quail Springs line, which is thirty miles long.

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	4.31	1.05	4.08	3.14
SAIDI (Min)	262.5	6.4	174.3	144.7
CAIDI (Min)	61.0	6.1	42.8	36.6

The above reliability is better than the established reliability threshold.

COTTONWOOD FEEDER #22

Cottonwood feeder #22 serves approximately 2,400 customers from Clarkdale west to Jerome. The feeder serves 75 customers on the Yavapai – Apache Nation. The feeder is 61% overhead and is approximately twenty-two miles in length. The Cottonwood substation has a single transmission source from the Quail Springs – Verde line, which is sixteen miles long.

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	0.01	0.22	1.51	0.58
SAIDI (Min)	0.8	16.2	96.7	37.9
CAIDI (Min)	78.3	72.3	64.0	71.5

The above reliability is better than the established reliability threshold.

GILA BEND FEEDER #22

Gila Bend feeder #22 serves approximately 500 customers between Sisson Road, I-8, Stout Road, and Citrus Valley Road. The feeder serves 100 customers on the San Lucy Village of the Tohono O'Odham Nation. The feeder is 98% overhead and is approximately eighteen miles in length. The Gila Bend 12kV bus is redundantly fed from the Gila Bend 230kV/69kV substation. The 69kV bus is redundantly fed from the 230kV substation, and the Bunyan – Gila Bend line and the Gila Bend – Gillespie line, which are twenty-one and thirty-nine miles respectively.

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	3.13	6.00	1.04	3.39
SAIDI (Min)	245.8	528.1	29.9	267.9
CAIDI (Min)	78.6	88.0	28.7	65.1

The above reliability is better than the established reliability threshold.

GRAY MOUNTAIN FEEDER #1

Gray Mountain feeder #1 serves 29 customers between Gray Mountain and Highway 89N. The feeder serves 1 customer within the Navajo Nation. The feeder is 86% overhead and is approximately one mile in length. The Gray Mountain substation has a single transmission source from the Black Mesa – Sandvig line, which is approximately forty-two mile in length.

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	1.69	0.07	4.32	2.03
SAIDI (Min)	670.3	8.6	473.6	384.2
CAIDI (Min)	396.7	120.0	109.6	208.8

The CAIDI average for Gray Mountain feeder #1 is above the APS reliability threshold for overhead feeders with a single transmission source. The major cause of the high CAIDI was a single 11 hour 53 minute outage in 2002. APS' Outage Log reports that two poles were down south of Gray Mountain substation. Service was restored to some loads from the Powell substation. However, the sectionalizing switches are 69K2939 (north of Gray Mountain substation) and 69K2927 (south of Spider Web substation), which isolates Gray Mountain, Wauneta, and Spider Web. They could not be restored until the poles were replaced. Absent this single event, all reliability thresholds would have been met.

The improvement plan for Cameron feeder #1 will also address the CAIDI issue with this feeder. Reliability improvements discussed under Tuba City #1 feeder will also improve SAIFI for this feeder.

HAMBLIN FEEDER #1

Hamblin feeder #1 serves 2 customers at the Tuba City Airport. Both customers are within the Navajo Nation. The feeder is 100% overhead and is approximately five miles in length. The Hamblin substation has a single transmission source from the Black Mesa – Tuba City line, which is also radially fed from the Black Mesa – Sandvig line. The two lines total approximately one-hundred twenty-nine miles in length.[13]

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	7.00	2.00	10.00	6.33
SAIDI (Min)	540.0	6960.0	60.0	2520.0
CAIDI (Min)	77.1	3480.0	6.0	1187.7

The SAIDI and CAIDI average for Hamblin feeder #1 is above the APS reliability threshold for overhead feeders with a single transmission source. The major cause of the high SAIDI and CAIDI was a single 114 hour 35 minute outage in 2003. APS' Outage Log reports that the outage to the feeder was extended due to a failed substation transformer. Note that this substation is a single transformer substation due to the relatively small load. During post-installation testing the spare transformer exhibited problems, possibly due to damage in transport. The power was restored after the transformer was replaced with a different spare. Absent this single event, all reliability thresholds would have been met

Spare transformer T1171, which is currently assigned to spare the Hamblin substation, was purchased in 1995, and is in stock (and tested) should the Hamblin transformer require replacement.

Reliability improvements discussed under Cameron feeder #1 and Tuba City feeder #1 will also benefit this feeder.

[13] Ibid., p. 5.

HAYFIELD DRAW FEEDER #2

Hayfield Draw feeder #2 serves approximately 450 customers in the Middle Verde area between Hayfield and Industrial Road. The feeder serves 156 customers on the Yavapai – Apache Nation. The feeder is 79% overhead and is approximately twenty-nine miles in length. The Hayfield Draw substation has a single transmission source from the Childs – Quail Springs line, which is approximately thirty miles in length.

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	0.78	2.27	0.71	1.26
SAIDI (Min)	38.3	55.6	235.3	109.8
CAIDI (Min)	48.9	24.5	331.3	134.9

The above reliability is better than the established reliability threshold.

KEAMS CANYON FEEDER #3

Keams Canyon feeder #3 serves approximately 1,800 customers between Polacca, Shongopovi, Oraibi, Bacobi and Hotevila. All customers are with the Hopi Reservation. The feeder is 97% overhead and is approximately forty-five miles in length. The Keams Canyon substation has a single transmission source from the Cholla – Keams Canyon line, which is approximately seventy-six miles in length.

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	8.01	3.97	2.00	4.66
SAIDI (Min)	508.8	1030.6	711.5	750.3
CAIDI (Min)	63.5	259.9	355.6	226.3

The SAIDI and CAIDI average for Keams Canyon feeder #3 is above the APS reliability threshold for overhead feeders with a single transmission source. The major cause of the high SAIDI and CAIDI were long duration transmission related outages. The APS' Outage Log report three instances of structural damage: two broken down guys in 2002, a pole that got washed out and fell over in 2003, and a broken tie on an insulator, causing the phase to come in contact with the crossarm, in 2004.

The Cholla – Keams Canyon 69kV line was "climbing inspected"; i.e., check tightness of hardware, in 1998 (required every ten years) and had the condition of its wood poles inspected in 2004. Any pole deemed to be under strength, or that was expected to be under strength within ten years, was repaired or replaced.

Much of the challenge in restoring power on the Cholla – Keams Canyon line is due to the difficulty in determining the cause and location of the outage. In an effort to improve the ability to locate the cause of sustained outages, fault locators have been added to the Cholla – Keams Canyon line at various locations. The locators light up when a fault is within its vicinity. This allows a Troubleman to be able to more rapidly drive the line to the actual fault location; thereby speeding up restoration.

In 2005, there have been four transmission related outages to the Keams Canyon substation. All were momentary. The suspected cause was lightning or high wind. After each outage, the line was patrolled but the cause was not able to be determined in three of the cases. In each of those cases, the fault was believed to be between the substation and the first fault locator. An additional fault locator has been added closer to the Cholla substation to assist in locating "close-in" faults. For the fourth case, an active bird nest was found, relocated, and the pole was raptor protected.

KEAMS CANYON FEEDER #5

Keams Canyon feeder #5 serves approximately 250 customers in Keams Canyon. All customers are within the Hopi Reservation. The feeder is 100% overhead

and is approximately six miles in length. The Keams Canyon substation has a single transmission source from the Cholla – Keams Canyon line, which is approximately seventy-six miles in length.

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	1.00	4.07	1.03	2.03
SAIDI (Min)	0.9	1044.3	672.9	572.7
CAIDI (Min)	0.9	256.5	651.2	302.8

The SAIDI and CAIDI average for Keams Canyon feeder #5 is above the APS reliability threshold for overhead feeders with a single transmission source. The cause and solution are discussed above for Keams Canyon #3.

LAGUNA FEEDER #1

Laguna feeder #1 servers approximately 600 customers between Highway 95, County 22, Avenue E, and the Colorado River. The feeder serves 9 customers with the Cocopah Reservation. The feeder is approximately 90% overhead and is approximately twenty-two miles in length. The Laguna substation has a single transmission source from the San Luis – Thirty-Second Street – Yucca line, which is approximately twenty-three miles in length.

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	2.02	7.18	8.53	5.91
SAIDI (Min)	3.2	236.6	333.0	190.9
CAIDI (Min)	1.6	33.0	39.1	24.5

The above reliability is better than the established reliability threshold.

LAGUNA FEEDER #5

Laguna feeder #5 servers 1,635 customers between County 14, Sunflower, Avenue E, and Avenue G. The feeder serves 190 customers within the East and West Cocopah Reservation. The feeder is 68% overhead and is approximately thirty miles in length. The Laguna substation has a single transmission source from the San Luis – Thirty-Second Street – Yucca line, which is approximately twenty-three miles in length.

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	4.14	7.26	7.38	6.26
SAIDI (Min)	20.6	141.8	130.6	97.7
CAIDI (Min)	5.0	19.5	17.7	14.1

The above reliability is better than the established reliability threshold.

MCGUIREVILLE FEEDER #10

McGuireville feeder #10 serves approximately 1,500 customers between Beaver Creek, Rimrock, and Lake Montezuma. The feeder serves 4 customers on the Yavapai – Apache nation. The feeder is 85% overhead and is approximately thirteen miles in length. The McGuireville substation is radially fed from the Quail Springs substation, which is approximately thirteen miles in length.

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	0.74	0.19	0.45	0.46
SAIDI (Min)	341.4	42.7	51.1	145.1
CAIDI (Min)	459.6	230.5	114.4	268.2

The CAIDI average for McGuireville feeder #10 is above the APS reliability threshold for overhead feeders with a single transmission source. The major cause of the high CAIDI was a single long duration

vegetation related outage in 2002. The APS' Outage Log reports that a tree fell on the McGuireville feeder #10. The tree contact was due to the natural failure of the tree and not due to tree growth into the line. The Vegetation Management patrol for McGuireville feeder #10 was completed in 2002 and is scheduled to be completed again by the end of this year.

MCGUIREVILLE FEEDER #14

McGuireville feeder #14 serves 24 customers between McGuireville south to Middle Verde Road. All customers are within the Yavapai – Apache Nation. The feeder is 79% overhead and is approximately twenty-nine miles in length. The McGuireville substation has a single transmission source from the Quail Springs substation, which is approximately thirteen miles in length.

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	0.09	0.03	0.05	0.05
SAIDI (Min)	19.1	1.8	1.6	7.5
CAIDI (Min)	5.83	1.37	3.20	109.8

The above reliability is better than the established reliability threshold.

MITRY FEEDER #1

Mitry feeder #1 serves 330 customers between Mitry Lake, County 7th Street, Avenue 6E, and Avenue 11E. The feeder serves 2 customers within the Fort Yuma Indian Reservation. The feeder is 96% overhead and is approximately twenty-nine miles in length. The Mitry substation has a single transmission source from the North Gila – Quechan line, which is approximately twelve miles in length.

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	2.84	0.29	1.89	1.67
SAIDI (Min)	138.8	30.4	142.6	103.9
CAIDI (Min)	48.9	103.7	75.5	76.0

The above reliability is better than the established reliability threshold.

PAPAGO FEEDER #9

Papago feeder #9 serves approximately 100 customers between the Gila River Indian Reservation, Teel Road, Cecille Road, and White Parker Road, and is partially owned by Electrical District 3. The feeder serves 2 customers on the Gila River Indian Community. The feeder is predominately overhead and is approximately twelve miles in length. The Papago substation has a single transmission source from the Maricopa (DOE) – Papago line, which is approximately seven miles in length.

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	6.09	1.57	1.43	3.03
SAIDI (Min)	514.4	258.3	267.7	346.8
CAIDI (Min)	84.5	165.0	186.5	145.4

The above reliability is better than the established reliability threshold.

PAPAGO FEEDER #11

Papago feeder #11 serves approximately 600 customers between the Reservation, Steen Road, Porter Road, and White Road, and is partially owned by Electrical District 3. The feeder serves 1 customer on the Gila River Indian Community. The feeder is predominately overhead and is approximately twenty-four miles in length. The Papago substation has a single transmission source from the Maricopa (DOE) – Papago line, which is approximately seven miles in length.

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	5.47	2.66	1.15	3.10
SAIDI (Min)	297.9	226.7	224.2	249.6
CAIDI (Min)	54.5	85.2	194.4	111.3

The above reliability is better than the established reliability threshold.

PINAL FEEDER #1

Pinal feeder #1 serves approximately 1,900 customers between Oak Avenue, Pinal Mountain, Russell Road, and the Apache Gold Casino. The feeder serves 102 customers on the San Carlos Apache Tribe Reservation. The feeder is 75% overhead and is approximately twenty-six miles in length. The Pinal substation has a single transmission source from the SRP Pinal substation.

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	3.24	2.26	1.50	2.33
SAIDI (Min)	108.8	220.2	89.7	139.6
CAIDI (Min)	33.5	97.3	59.9	63.6

The above reliability is better than the established reliability threshold.

PRESCOTT CITY FEEDER #3

Prescott City feeder #3 serves approximately 1,100 customers between Highway 89 to Old Dump Rd, south to Sheldon. The feeder serves 70 customers on the Yavapai Prescott Indian Tribe Reservation. The feeder is 62% underground and is approximately four miles in length. The Prescott City substation is redundantly fed from the Prescott City – Delano – Willow Lake, Prescott City – White Spar, and Prescott City – Willow Lake lines, which are seven, one, and six miles respectively.

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	1.00	2.02	0.02	1.01
SAIDI (Min)	4.0	158.5	2.3	54.9
CAIDI (Min)	4.0	78.4	146.3	76.2

The above reliability is better than the established reliability threshold.

SUNDOG FEEDER #5

Sundog feeder #5 serves approximately 600 customers between Highway 89 (south of Old Dump Road) south to Holliday Hills. The feeder serves 82 customers on the Yavapai Prescott Indian Tribe Reservation. The feeder is 100% underground and is approximately one mile in length. The Sundog substation is redundantly fed from the Bald Mountain – Sundog and Sundog – Willow Lake lines, which are five and six miles respectively. In 2002 and 2003, the tribal territory was served by Sundog #12.

Reliability data for the feeder is as follows:

	2002*	2003*	2004	Avg.
SAIFI	2.09	0.33	0.29	0.90
SAIDI (Min)	68.4	43.5	29.4	47.1
CAIDI (Min)	32.8	133.8	102.6	89.7

* Previously served by Sundog feeder #12

The above reliability is better than the established reliability threshold.

SUNSHINE FEEDER #1

Sunshine feeder #1 serves approximately 15 customers between Two Guns and Meteor Crater. The feeder serves 4 customers on the Navajo Nation. The feeder is 100% overhead and is approximately fifteen miles in length. The Sunshine substation has a single transmission source from the Coconino – Winslow line, which is sixty-one miles.

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	3.62	5.31	7.08	5.33
SAIDI (Min)	193.8	143.1	230.8	189.2
CAIDI (Min)	53.6	27.0	32.6	37.7

The above reliability is better than the established reliability threshold.

THIRTY-SECOND STREET FEEDER #1

Thirty-Second Street feeder #1 serves 998 customers between 32 Street, County 18, Avenue 2E, and Avenue D. The feeder serves 5 customers with the East Cocopah Indian Reservation. The feeder is 84% overhead and is approximately fifty-four miles in length. The Thirty-Second Street substation is redundantly fed from the Tenth Street – Thirty-Second Street, Ivalon – Thirty-Second Street, and Marine Air – Thirty-Second Street lines, which are 3, 4, and 9 miles respectively.

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	0.34	1.71	2.48	1.51
SAIDI (Min)	16.2	248.0	561.9	275.4
CAIDI (Min)	48.1	145.5	226.7	140.1

The above reliability is better than the established reliability threshold.

TONALEA FEEDER #1

Tonalea feeder #1 serves 3 customers at the sewer lagoon southwest of Tuba City. All customers are within the Navajo Nation. The feeder is 100% overhead and is approximately one mile in length. The Tonalea substation has a single transmission source from the Black Mesa – Tuba City line, which is also radially fed from the Black Mesa – Sandvig line. The two lines total approximately one-hundred twenty-nine miles in length.[14]

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	7.00	2.00	9.00	6.00
SAIDI (Min)	660.0	200.0	160.0	340.0
CAIDI (Min)	94.3	100.0	17.8	70.7

The above reliability is better than the established reliability threshold.

Reliability improvements discussed under Cameron feeder #1 and Tuba City feeder #1 will also benefit this feeder.

TONTO FEEDER #4

Tonto feeder #4 serves approximately 2,400 customers between South Longhorn, Tonto Basin, McLane Road, and the Sanitation Plant. The feeder serves 48 customers on the Tonto Apache Tribe Reservation. The feeder is 71% overhead and is approximately one mile in length. The Tonto substation is redundantly fed from the Childs – Tonto and Preacher Canyon – Tonto lines. Because, there is only one line breaker at Tonto (on the Childs line) however, an event on the Preacher Canyon – Tonto line also trips the Childs – Tonto line. A new 345/69kV transformer will be installed, within the current 10-year planning window, at the Matazal substation and will eliminate this issue. The lines are twenty-eight and ten miles respectively

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	5.07	7.71	9.90	7.56
SAIDI (Min)	140.2	452.3	113.5	235.3
CAIDI (Min)	27.6	58.7	11.5	32.6

[14] Ibid., p. 5.

The SAIFI average for Tonto feeder #4 is above the APS reliability threshold for overhead feeders with a single transmission sources. To reduce SAIFI, APS has undertaken a significant amount of work in recent years that is expected to improve performance. APS has begun building the new Matazal substation near Rye Creek Road and the 345kV corridor. The Company has also been extending the 69kV transmission line from Tonto substation to the new Matazal substation, with the last three mile segment scheduled to be completed this year. While the 69kV line is being built, Tonto feeder #4 is being underbuilt new on the new line. In addition, many of the current customers served on today's Tonto feeder #4 will be served from the two new feeders from the new Matazal substation, thereby reducing the line length (and outage exposure) of Tonto feeder #4.

TUBA CITY FEEDER #1

Tuba City feeder #1 serves approximately 1,800 customers on the north side of Tuba City south to approximately Highway 160. All customers are within the Navajo Nation. The feeder is 82% overhead and is approximately eight miles in length. The Tuba City substation has a single transmission source from the Black Mesa – Tuba City line, which is also radially fed from the Black Mesa – Sandvig line. The two lines total approximately one-hundred twenty-nine miles in length.[15]

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	8.20	2.03	13.74	7.99
SAIDI (Min)	820.2	219.8	351.2	463.7
CAIDI (Min)	100.0	108.3	25.6	77.9

[15] Ibid., p. 5.

The SAIFI average for Tuba City feeder #1 is above the APS reliability threshold for overhead feeders with a single transmission source. The major cause of the high SAIFI is transmission related outages on both the Black Mesa – Tuba City line and the Black Mesa – Sandvig line. Fault locators, like those that have been installed on the Cholla – Keams Canyon line, will be installed on both lines in 2005 in order to determine the location and cause of each outage.

TUBA CITY FEEDER #3

Tuba City feeder #3 serves approximately 1,000 customers on the south of Tuba City and east to Rare Metals Road. All customers are within the Hopi Reservation and Navajo Nation. The feeder is 78% overhead and is approximately eleven miles in length. The Tuba City substation has a single transmission source from the Black Mesa – Tuba City line, which is also radially fed from the Black Mesa – Sandvig line. The two lines total approximately one-hundred twenty-nine miles in length.[16]

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	7.04	3.08	9.20	6.44
SAIDI (Min)	725.7	265.5	262.2	417.5
CAIDI (Min)	103.1	86.1	28.4	72.5

The above reliability is better than the established reliability threshold.

Reliability improvements discussed under Cameron feeder #1 and Tuba City feeder #1 will also benefit this feeder.

VALLEY FARMS FEEDER #6

Valley Farms feeder #6 serves approximately 600 customers between

[16] Ibid., p. 5.

Bonneybrook Road, Bolling Road, Hiscock Road, and Highway 287. The feeder serves 29 customers on the Tohono O'Odham Nation. The feeder is 79% overhead and is approximately seven miles in length. The Valley Farms substation has a single transmission source from the Coolidge – Oracle Junction line, which is not owned or operated by APS.

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	2.06	1.01	3.01	2.03
SAIDI (Min)	144.1	92.3	117.8	118.1
CAIDI (Min)	70.0	91.1	39.2	66.7

The above reliability is better than the established reliability threshold.

VISTA FEEDER #6

Vista feeder #3 serves approximately 1,200 customers between McCartney Road, Trekell Road, Chemehuevi, and the Reservation. The feeder serves 1 customer on the Gila River Indian Community. The feeder is 54% overhead and is approximately twelve miles in length. The Vista substation is redundantly fed from the Eastgate – Vista line and the Santa Rosa – Vista line, which are approximately five and fifteen miles respectively.

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	1.21	4.13	0.99	2.11
SAIDI (Min)	21.6	106.0	141.3	89.7
CAIDI (Min)	17.8	25.7	143.1	62.2

The above reliability is better than the established reliability threshold.

WHY FEEDER #1

Why feeder #1 serves approximately 350 customers between Why and Lukeville. The feeder serves 1 wholesale customer on the Tohono O'Odham Nation. The feeder is 98% overhead and is approximately thirty-two miles in length. The Why substation has a single transmission source from the Gila Bend – Why line, which is approximately fifty-six miles in length.

Reliability data for the feeder is as follows:

	2002	2003	2004	Avg.
SAIFI	3.02	7.01	3.04	4.36
SAIDI (Min)	45.3	1733.2	1226.1	1001.6
CAIDI (Min)	15.0	247.4	403.1	221.8

The SAIDI and CAIDI averages for Why feeder #1 are above the APS reliability threshold for overhead feeders with a single transmission sources. The major cause of the high SAIDI and CAIDI were long duration transmission related outages due to structural issues. The APS' Outage Log in 2003 reported a pole burnt down between Ajo and Coffeepot and 5 poles blown down in a storm in 2004.

This line was "climbing inspected"; i.e., check tightness of hardware, in 2002 and will have the condition of its wood poles inspected next year. Any pole deemed to be under strength, or that is expected to be under strength within ten years, will be repaired or replaced.

IMPACT OF TRANSMISSION ON RELIABILITY

As demonstrated by the above feeder by feeder analysis, transmission reliability plays a large part in distribution reliability in rural areas. Of the nine feeders identified as having a reliability indicator over the threshold, two-thirds were due to transmission related causes.

It is instructive to note that the three transmission lines in question (Sandvig –

Black Mesa – Tuba City at 129 miles, Cholla – Keams Canyon at 76 miles, and Gila Bend – Why at 56 miles) are the 1st, 2nd, and 7th longest 69kV transmission lines (out of 220 69kV lines) in APS' system. Although there is not an exact statistical match between outage frequency and line length (other factors, such as pole spacing and conductor spacing play a role), from empirical data it is well know that longer lines exhibit higher failure rates.

APS undertook a review to determine if relevant reliability guidelines were being met by the transmission system. North American Electric Reliability Council (NERC), Western Electricity Coordinating Council (WECC), and other industry sources were researched. NERC and WECC *Minimum Operating Reliability Criteria (MORC)* concern themselves with the "interconnected bulk electric system", which the NERC Board of Trustees at its April 1995 meeting defined as:

> The bulk electric system is a term commonly applied to that portion of an electric utility system, which encompasses the electrical generation resources, transmission lines, interconnections with neighboring systems, and associated equipment, generally operated at voltages of 100 kV or higher.

Hence, the lines serving the Tribal Territories are operated at 69kV and are not subject to NERC or WECC planning and reliability standards. Further, the standards note that "[p]lanned or controlled interruption of electric supply to radial customers or some local network customers, connected to or supplied by the faulted element or by the affected area, may occur in certain areas without impacting the overall security of the interconnected transmission systems." For the long radial lines discussed previously (Sandvig – Black Mesa – Tuba City, Cholla – Keams Canyon, and Gila Bend – Why) in this study, none adversely impact the interconnected network.

APS reviewed SGS Statistical Service's, *2005 SGS Transmission Reliability Benchmarking Study* as a source of reference to determine the relative reliability of the APS 69kV system. The study "is the most comprehensive statistical and comparative study of historical transmission reliability in the world"[17] and included 31 participants (including APS) and "approximately 51% of the US transmission grid, based on 2003 NERC bulk power mileage".[18]

When compared against other western utilities from 2000 - 2004, APS' 69kV T-SAIFI (Transmission SAIFI) is 0.5 vs. 0.4 for other western utilities and APS' T-SAIDI (Transmission SAIDI) is 50 minutes vs. 56 minutes for other western utilities. APS' service is therefore comparable with other western utilities in the survey. Similar results were shown in a Canadian Electric Association study [5] for all voltage levels. The study reported a T-SAIFI of approximately 0.65 and a T-SAIDI of approximately 30 minutes.

The *2005 SGS Transmission Reliability Benchmarking Study* also utilizes a proprietary composite reliability indicator called TACS (Transmission Availability Composite Score), which sums outage frequency, outage duration, short-term time-between-failure, and long-term time-between-failure and converts them into a percentile score between 0 and 1000 (higher being better). APS' TACS score for its 69kV system in 2004 was 440, and a five year ranking of 431. The average of all participants in 2004 was 396, and 1st quartile was 469 indicating that APS was in the 2nd quartile. The study also showed a positive 5-year trend for all voltage levels of transmission. The study encompassed 4,555 circuits and 51,331 line miles.

CONCLUSION

Overall, the reliability of feeders serving tribal territories is good. Benchmarking data has been provided that shows that overall

[17] SGS Statistical Services, *2005 SGS Transmission Reliability Benchmarking Study*, p. 1.

[18] Ibid., p. 1.

APS' transmission reliability compares favorably with the industry. In addition, the Company has demonstrated positive 5-year performance trend for all transmission voltage levels, and that the subject transmission lines are in compliance with NERC and WECC requirements. Of thirty-three feeders reviewed, nearly three-fourths have reliability indices than the established reliability thresholds. Corrective action efforts were identified for nine feeders. These corrective actions include:

- Installation of a capacitor bank at the Tuba City substation in 2006;
- Replacement of a manual switch with a circuit breaker at WAPA's Powell substation in 2006;
- Adding automation to switches on the Black Mesa – Tuba City and Black Mesa – Sandvig lines in 2005;
- Maintaining a spare transformer for the Hamblin substation (complete);
- Installation of fault locators on the Cholla – Keams Canyon line (complete);
- Vegetation patrol of the McGuireville #10 feeder in 2005;
- Installation of the Matazal substation, extension of the 69kV line from Tonto substation, and under-building of new 12kV feeder to be completed by 2006;
- Installation of fault locators on the Black Mesa – Tuba City and Black Mesa – Sandvig lines by 2005; and
- Wood pole inspection of the Gila Bend – Why line on 2006.

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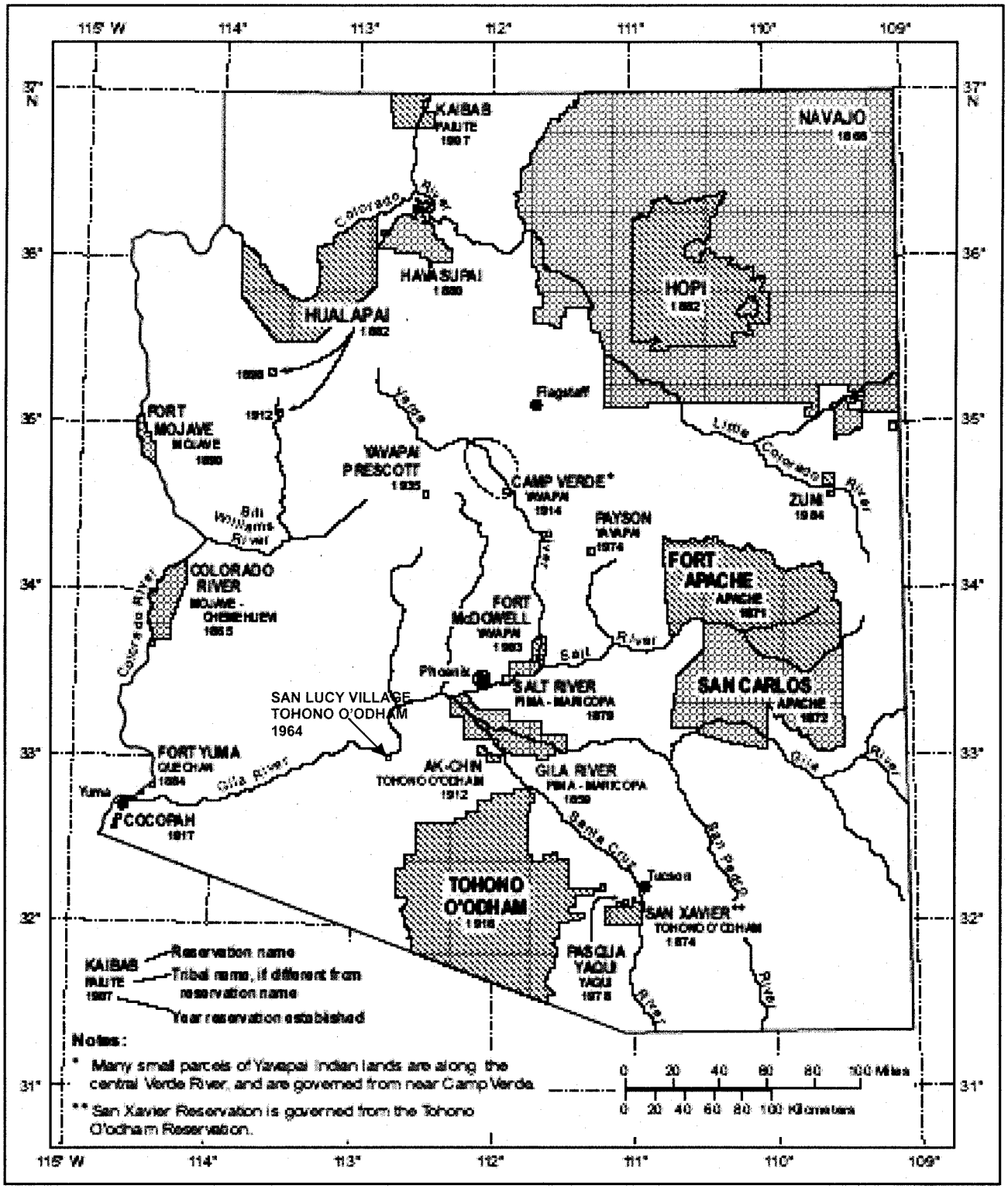
ATTACHMENT 1 – SUMMARY OF RELIABILITY WITHIN TRIBAL TERRITORIES

	SAIFI			SAIDI (Min)			CAIDI (Min)		
	2002	2003	2004	2002	2003	2004	2002	2003	2004
Cocopah Reservation									
Cocopah feeder #1	0.06	6.86	5.19	5.9	557.1	216.4	92.2	81.2	41.7
Laguna feeder #1	2.02	7.18	8.53	3.2	236.6	333.0	1.6	33.0	39.1
Laguna feeder #5	4.14	7.26	7.38	20.6	141.8	130.6	5.0	19.5	17.7
Thirty-Second Street feeder #1	0.34	1.71	2.48	16.2	248.0	561.9	48.1	145.5	226.7
Fort Yuma Indian Reservation									
Mitry feeder #1	2.84	0.29	1.89	138.8	30.4	142.6	48.9	103.7	75.5
Gila River Indian Community									
Papago feeder #9	6.09	1.57	1.43	514.4	258.3	267.7	84.5	165.0	186.5
Papago feeder #11	5.47	2.66	1.15	297.9	226.7	224.2	54.5	85.2	194.4
Vista feeder #6	1.21	4.13	0.99	21.6	106.0	141.3	17.8	25.7	143.1
Hopi Tribe									
Keams Canyon feeder #3	8.01	3.97	2.00	508.8	1030.6	711.5	63.5	259.9	355.6
Keams Canyon feeder #5	1.00	4.07	1.03	0.9	1044.3	672.9	0.9	256.5	651.2
Hopi Tribe and Navajo Nation									
Tuba City feeder #3	7.04	3.08	9.20	725.7	265.5	262.2	103.1	86.1	28.4
Navajo Nation									
Bear Springs feeder #1	7.00	2.00	9.00	540.0	120.0	60.0	77.1	60.0	6.7
Cameron feeder #1	8.00	2.95	9.17	581.0	901.2	260.4	72.6	305.3	28.4
Cameron feeder #3	7.04	2.01	9.00	500.2	639.6	224.2	71.1	318.3	24.9
Gray Mountain feeder #1	1.69	0.07	4.32	670.3	8.6	473.6	396.7	120.0	109.6
Hamblin feeder #1	7.00	2.00	10.00	540.0	6960.0	60.0	77.1	3480.0	6.0
Sunshine feeder #1	3.62	5.31	7.08	193.8	143.1	230.8	53.6	27.0	32.6
Tonalea feeder #1	7.00	2.00	9.00	660.0	200.0	160.0	94.3	100.0	17.8
Tuba City feeder #1	8.20	2.03	13.74	820.2	219.8	351.2	100	108.3	25.6
Salt River Pima Indian Nation									
Cement – Verde 69kV line	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
San Carlos Apache Tribe									
Pinal feeder #1	3.24	2.26	1.50	108.8	220.2	89.7	33.5	97.3	59.9
Tohono O'Odham Nation									
Caywood feeder #1	6.17	2.00	1.13	358.0	156.0	350.0	58.1	78.0	308.8
Gila Bend feeder #22	3.13	6.00	1.04	245.8	528.1	29.9	78.6	88.0	28.7
Valley Farms feeder #6	2.06	1.01	3.01	144.1	92.3	117.8	70.0	91.1	39.2
Why feeder #1	3.02	7.01	3.04	45.3	1733.2	1226.	15.0	247.4	403.1
Tonto Apache Tribe									
Tonto feeder #4	5.07	7.71	9.90	140.2	452.3	113.5	27.6	58.7	11.5
Yavapai Prescott Indian Tribe									
Prescott City feeder #3	1.00	2.02	0.02	4.0	158.5	2.3	4.0	78.4	146.3
Sundog feeder #5	0.00	0.00	0.29	0.00	0.00	29.4	0.00	0.00	102.6
Yavapai – Apache Nation									
Copper Canyon feeder #2	4.31	1.05	4.08	262.5	6.4	174.3	61.0	6.1	42.8
Cottonwood feeder #22	0.01	0.22	1.51	0.8	16.2	96.7	78.3	72.3	64.0
Hayfield Draw feeder #2	0.78	2.27	0.71	38.3	55.6	235.3	48.9	24.5	331.3
McGuireville feeder #10	0.74	0.19	0.45	341.4	42.7	51.1	459.6	230.5	114.4
McGuireville feeder #14	0.09	0.03	0.05	19.1	1.8	1.6	5.83	1.37	3.20

ATTACHMENT 2 – MAP OF TRIBAL TERRITORIES WITHIN ARIZONA

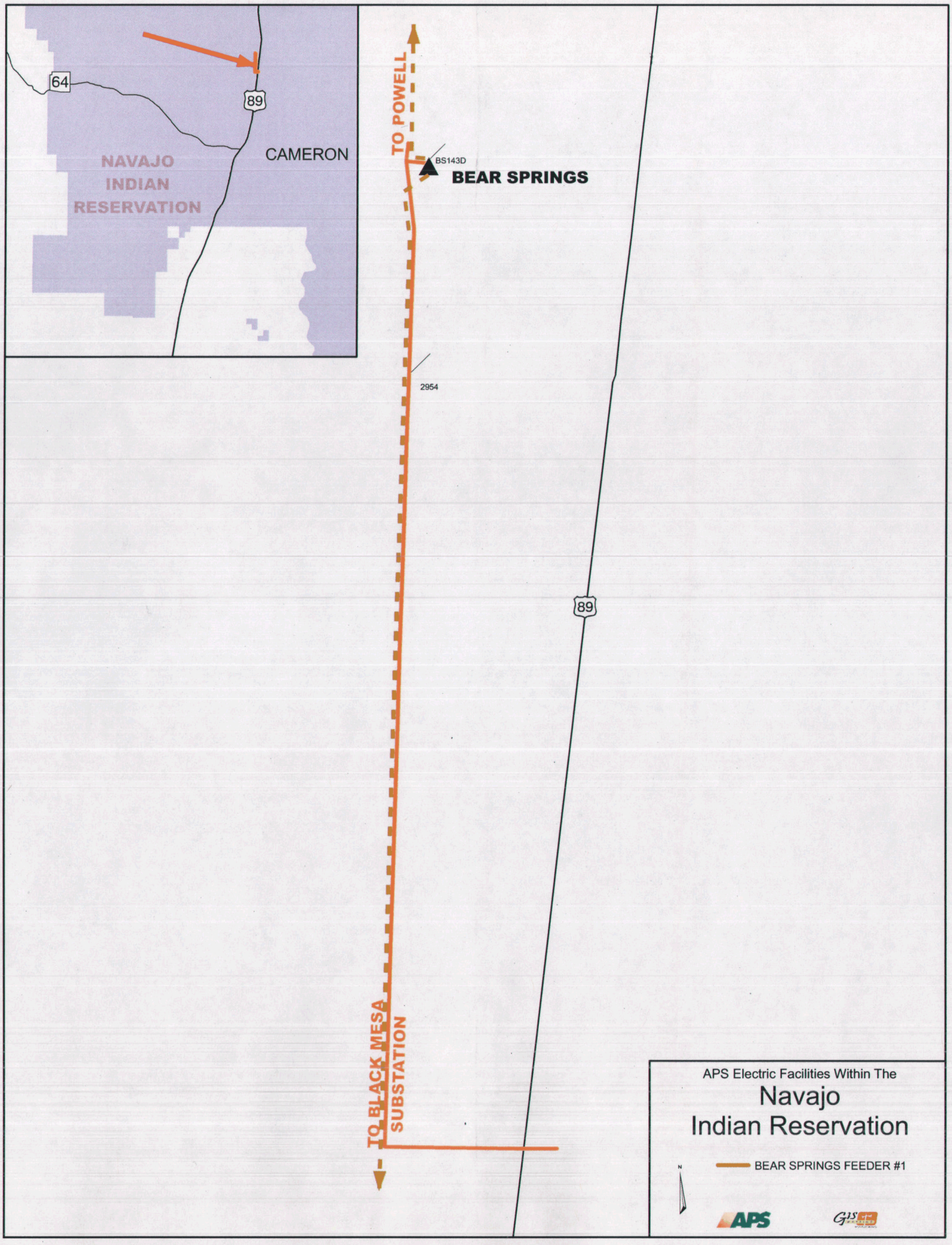


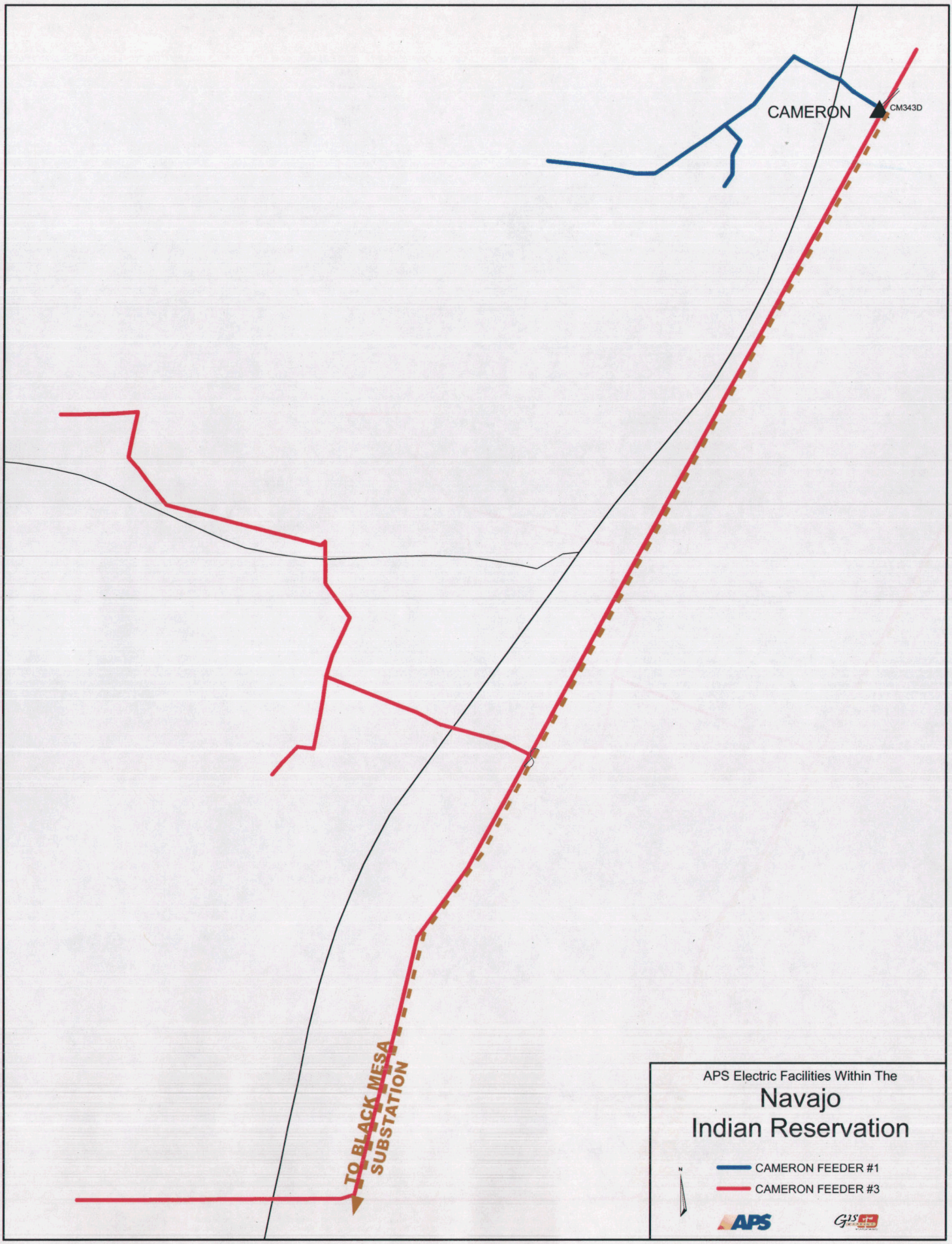
Arizona's Indian Reservations

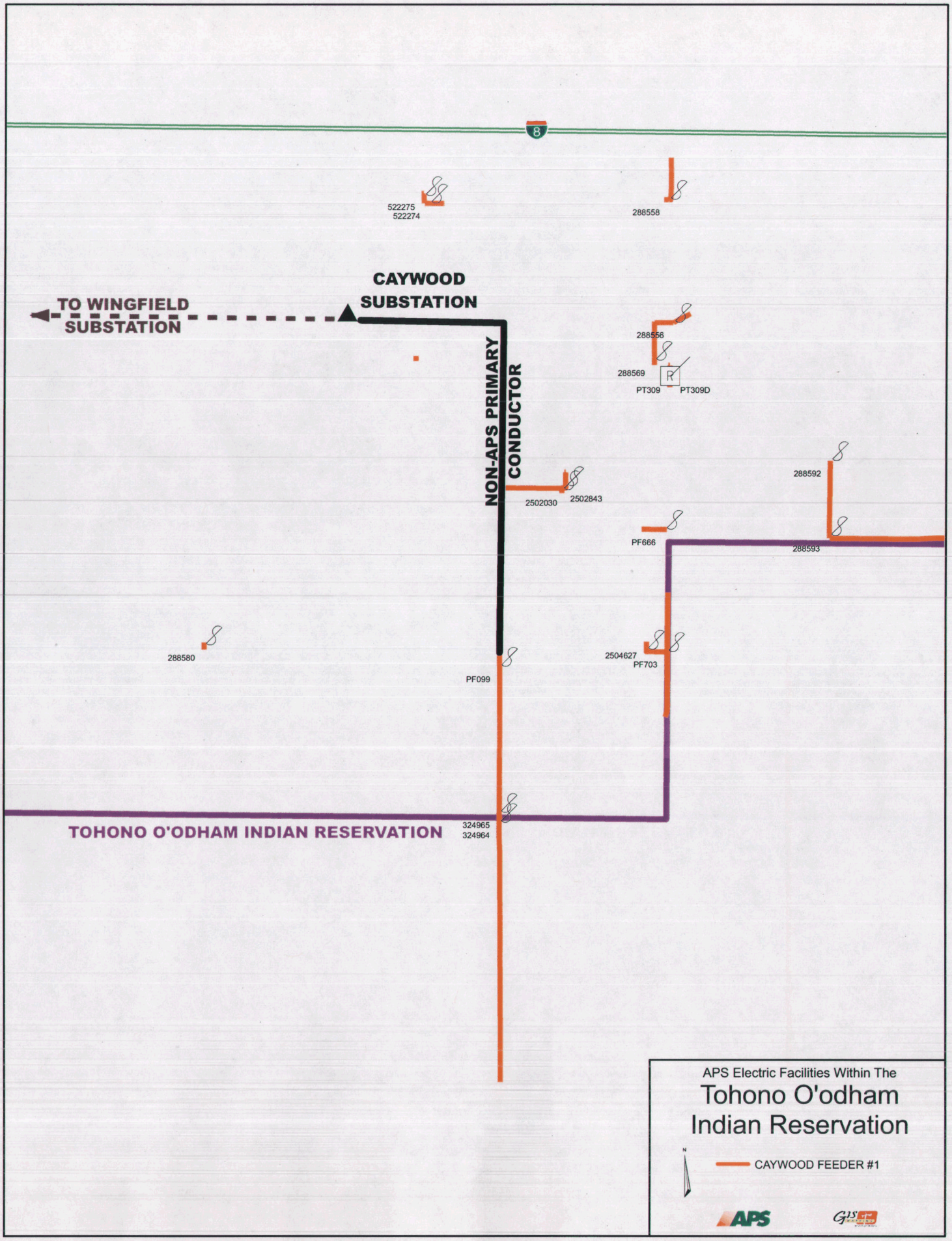
ARIZONA GEOGRAPHIC ALLIANCE

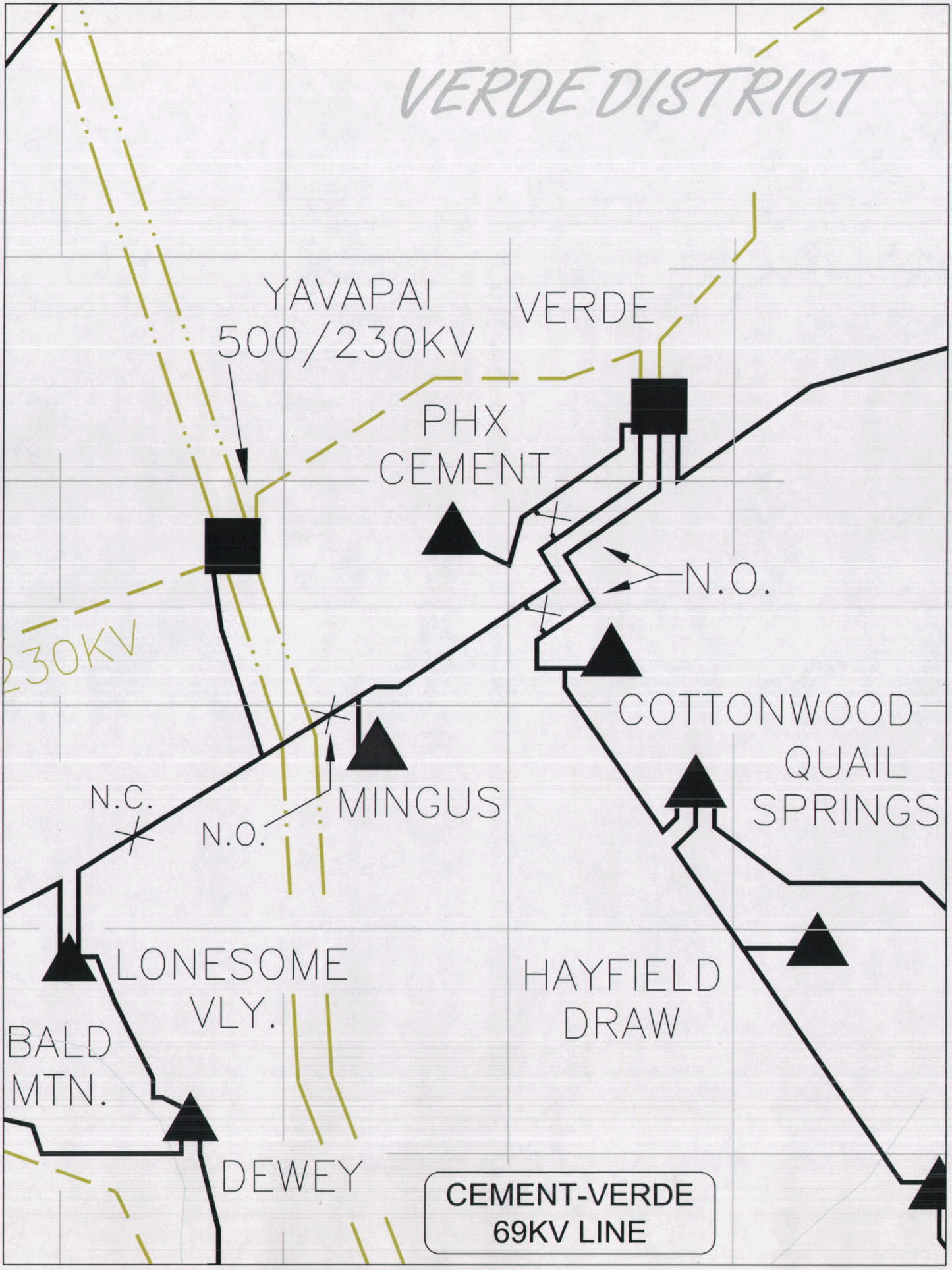
Courtesy: Arizona Geographic Alliance
Department of Geography, Arizona State University
Douglas Minnis

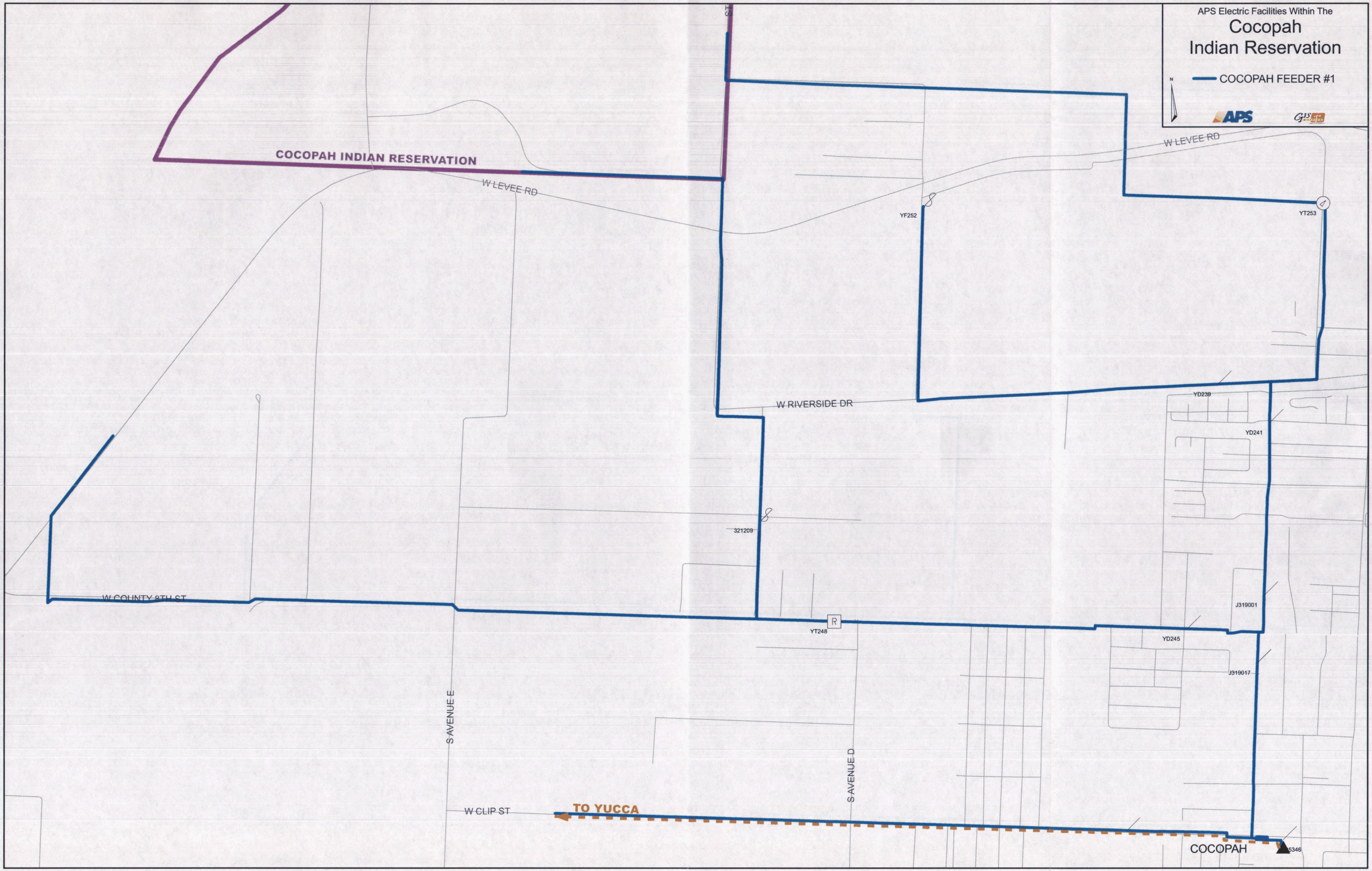
APPENDIX A - FEEDER MAPS FOR APS FACILITIES SERVING TRIBAL TERRITORIES

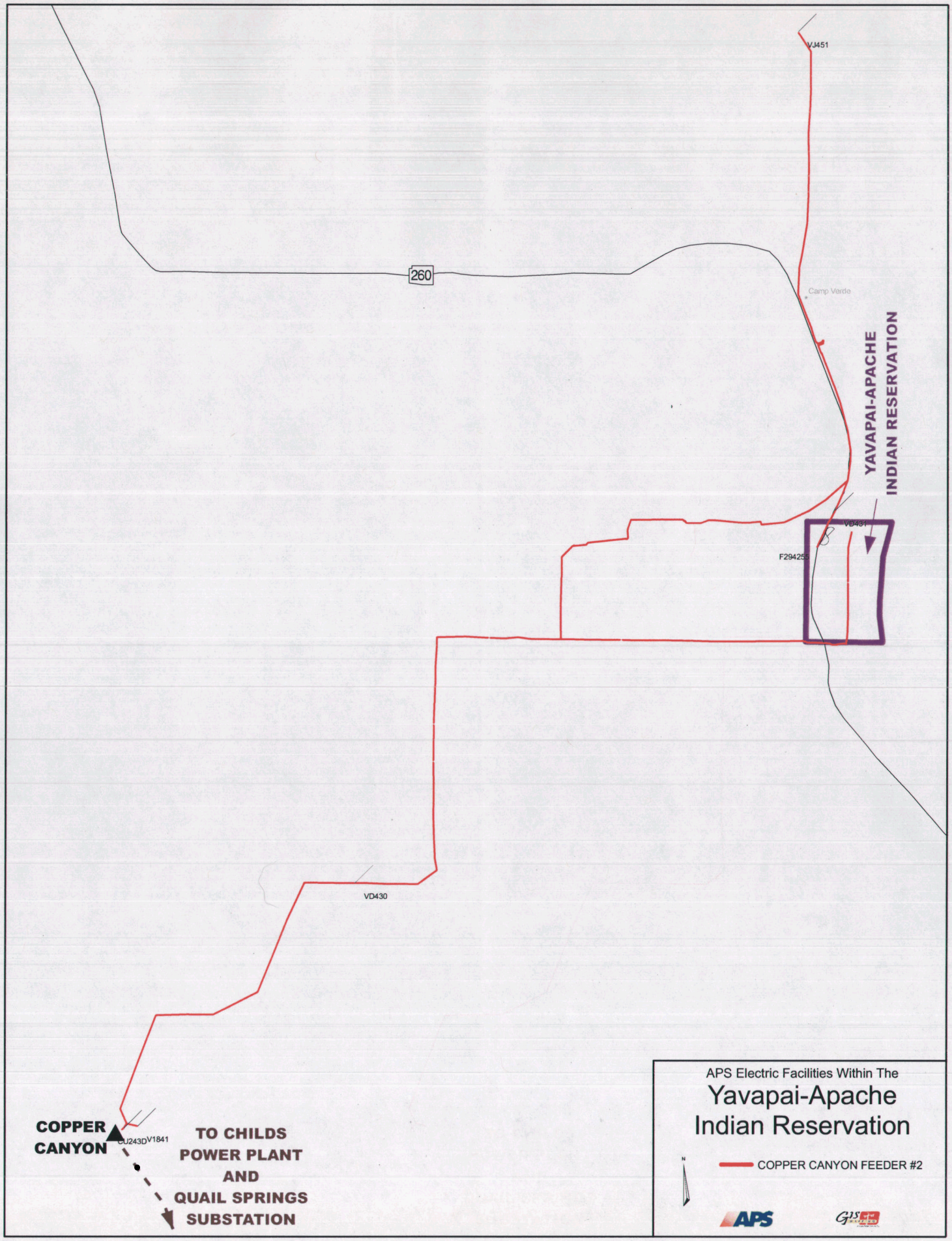

64
89
CAMERON
NAVAJO
INDIAN
RESERVATION
TO POWELL
BS143D
BEAR SPRINGS
2954
89
TO BLACK MESA
SUBSTATION
APS Electric Facilities Within The
Navajo
Indian Reservation
BEAR SPRINGS FEEDER #1
N
APS


CAMERON
CM343D
TO BLACK MESA SUBSTATION
APS Electric Facilities Within The
Navajo
Indian Reservation
CAMERON FEEDER #1
CAMERON FEEDER #3
N
APS


8
522275
522274
288558
CAYWOOD
SUBSTATION
TO WINGFIELD
SUBSTATION
288556
288569
R
PT309
PT309D
NON-APS PRIMARY
CONDUCTOR
2502030
2502843
288592
PF666
288593
288580
PF099
2504627
PF703
324965
324964
TOHONO O'ODHAM INDIAN RESERVATION
APS Electric Facilities Within The
Tohono O'odham
Indian Reservation
N
CAYWOOD FEEDER #1
APS
GIS


VERDE DISTRICT
YAVAPAI
500/230KV
VERDE
PHX
CEMENT
N.O.
230KV
COTTONWOOD
QUAIL
SPRINGS
MINGUS
N.C.
N.O.
LONESOME
VLY.
HAYFIELD
DRAW
BALD
MTN.
DEWEY
CEMENT-VERDE
69KV LINE

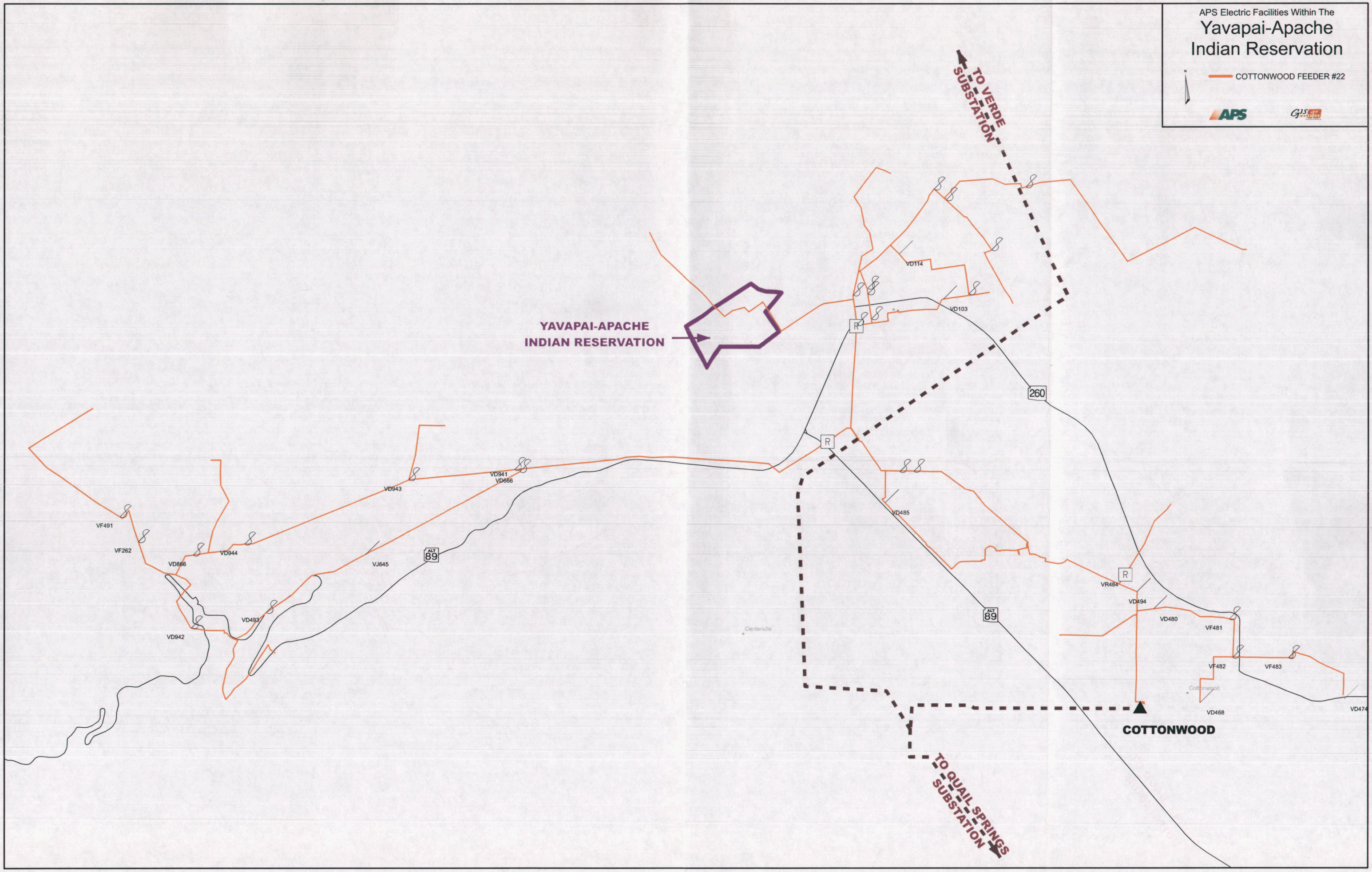

APS Electric Facilities Within The
Cocopah
Indian Reservation
COCOPAH FEEDER #1
N
APS
COCOPAH INDIAN RESERVATION
W LEVEE RD
W LEVEE RD
YF252
YT253
W RIVERSIDE DR
YD239
YD241
321209
W COUNTY 8TH ST
J319001
YT248
YD245
J319017
S AVENUE E
S AVENUE D
W CLIP ST
TO YUCCA
COCOPAH
5346

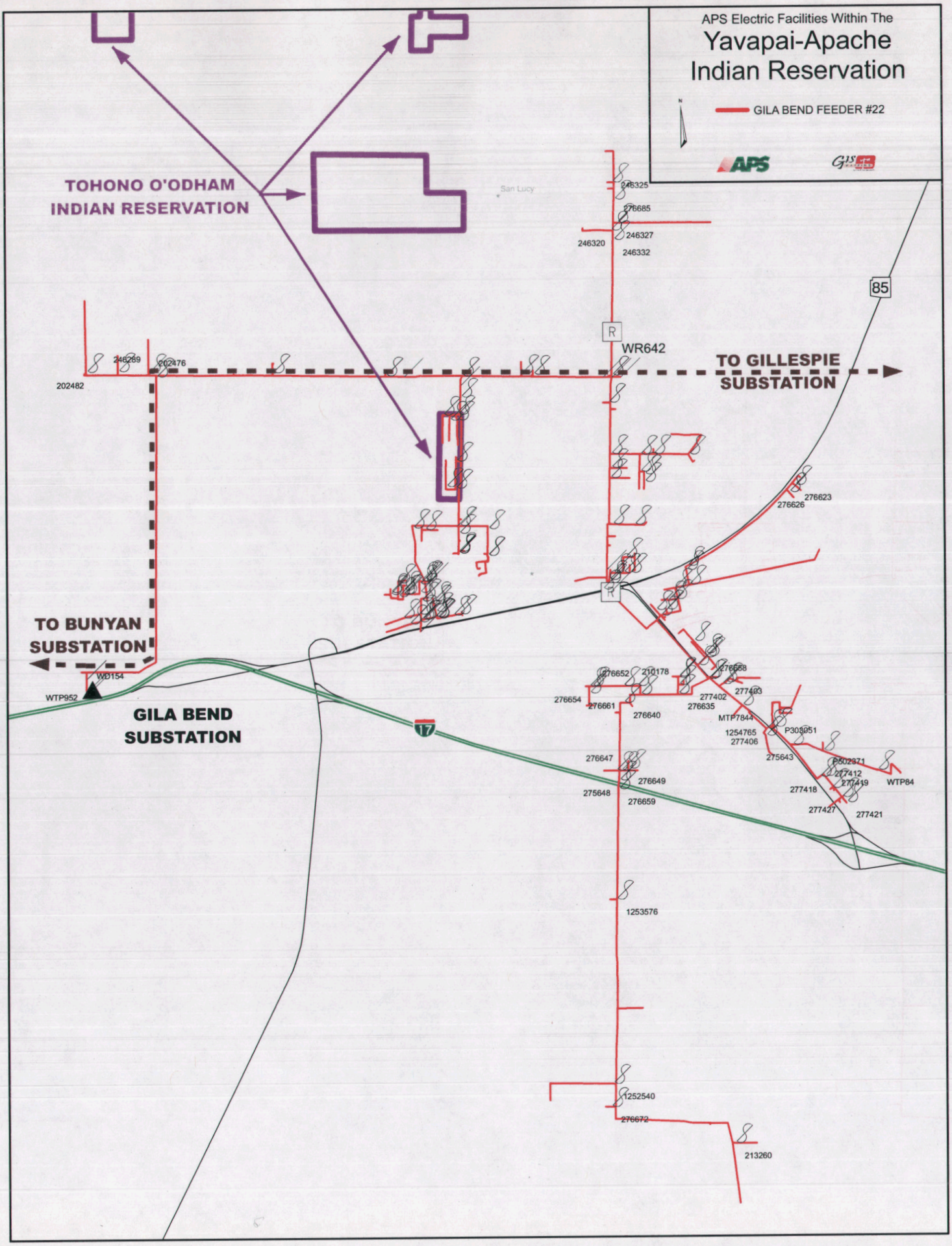

VJ451
260
Camp Verde
YAVAPAI-APACHE
INDIAN RESERVATION
VD431
F29425
VD430
COPPER
CANYON
CU243D
V1841
TO CHILDS
POWER PLANT
AND
QUAIL SPRINGS
SUBSTATION
APS Electric Facilities Within The
Yavapai-Apache
Indian Reservation
N
COPPER CANYON FEEDER #2
APS

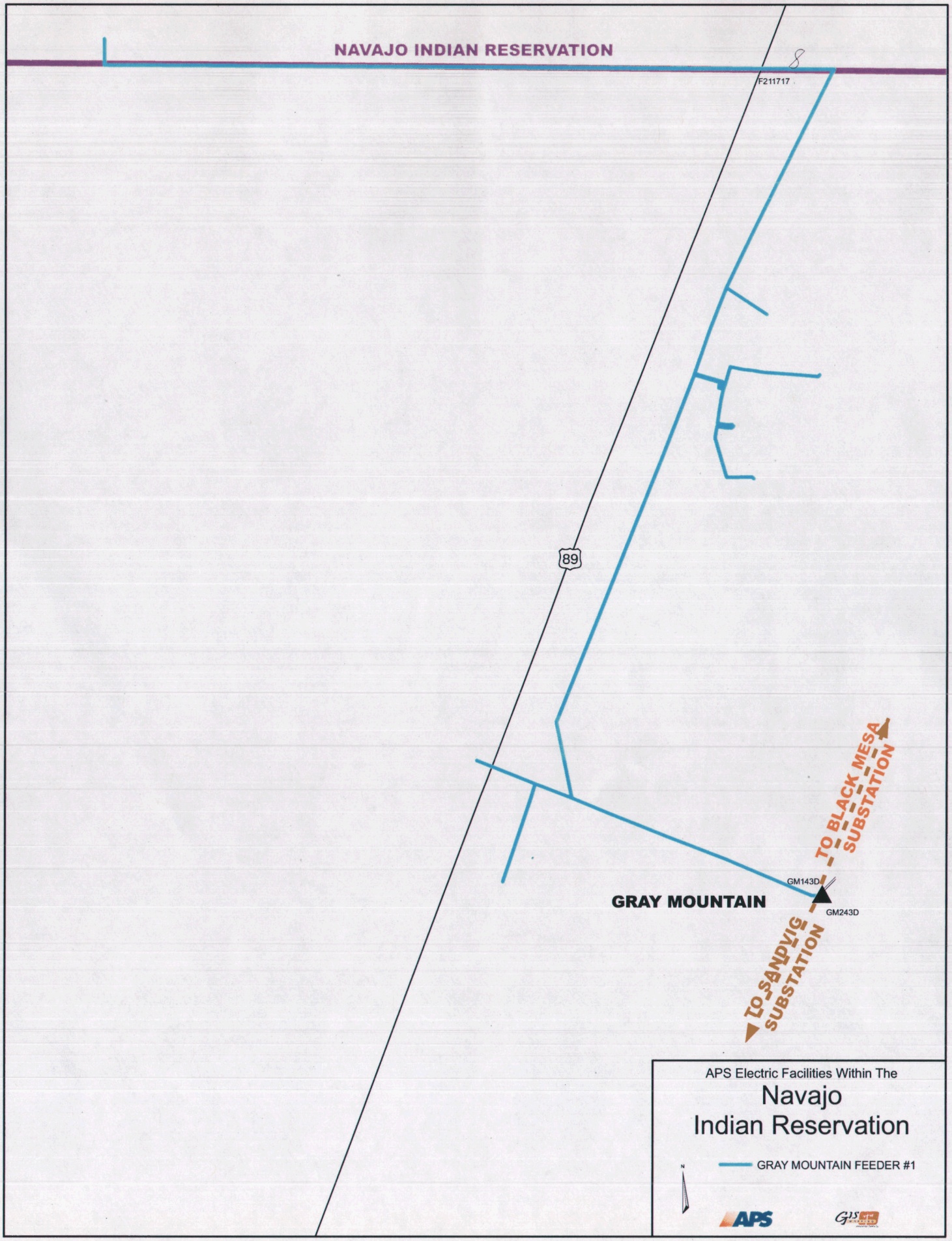
APS Electric Facilities Within The

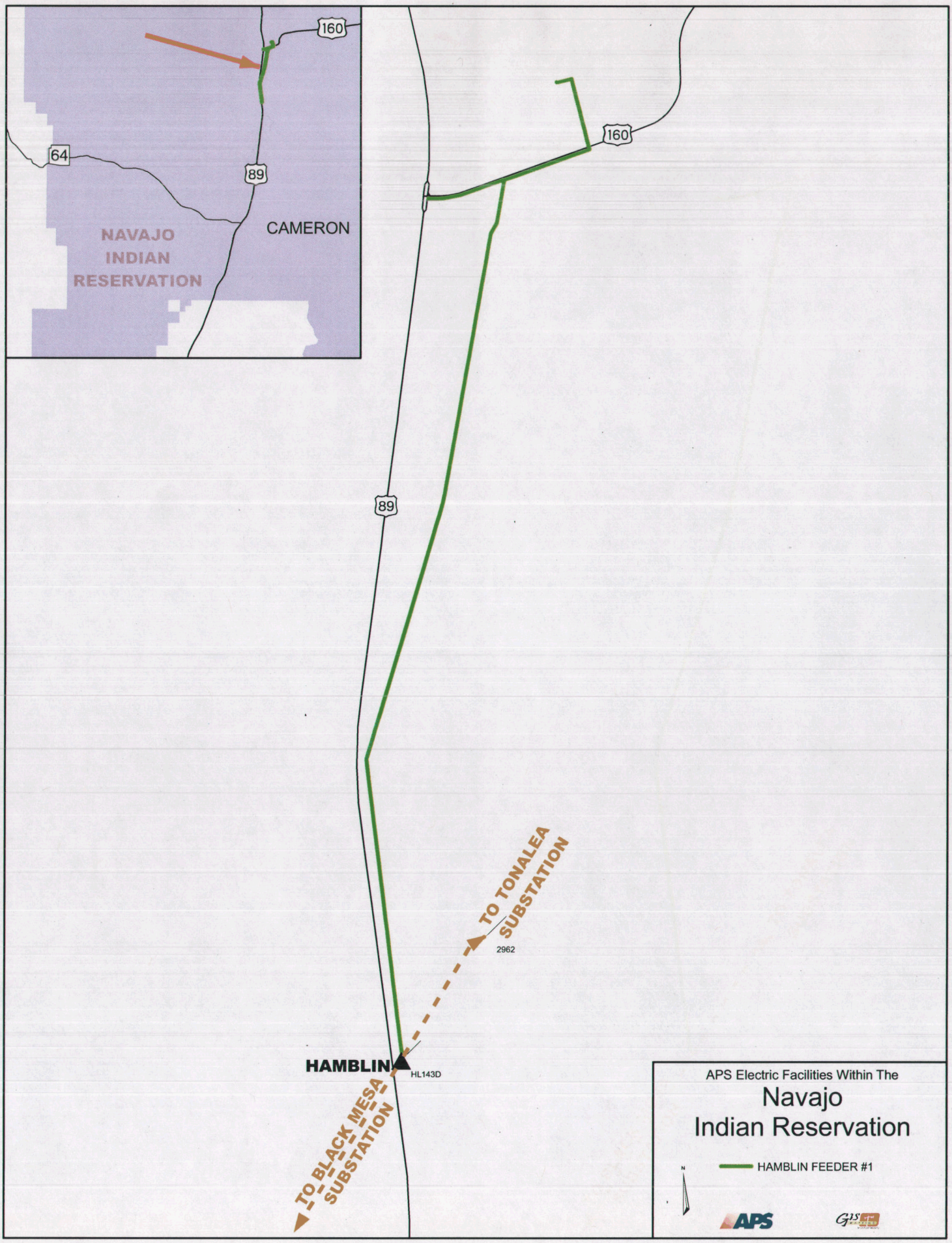
Yavapai-Apache Indian Reservation

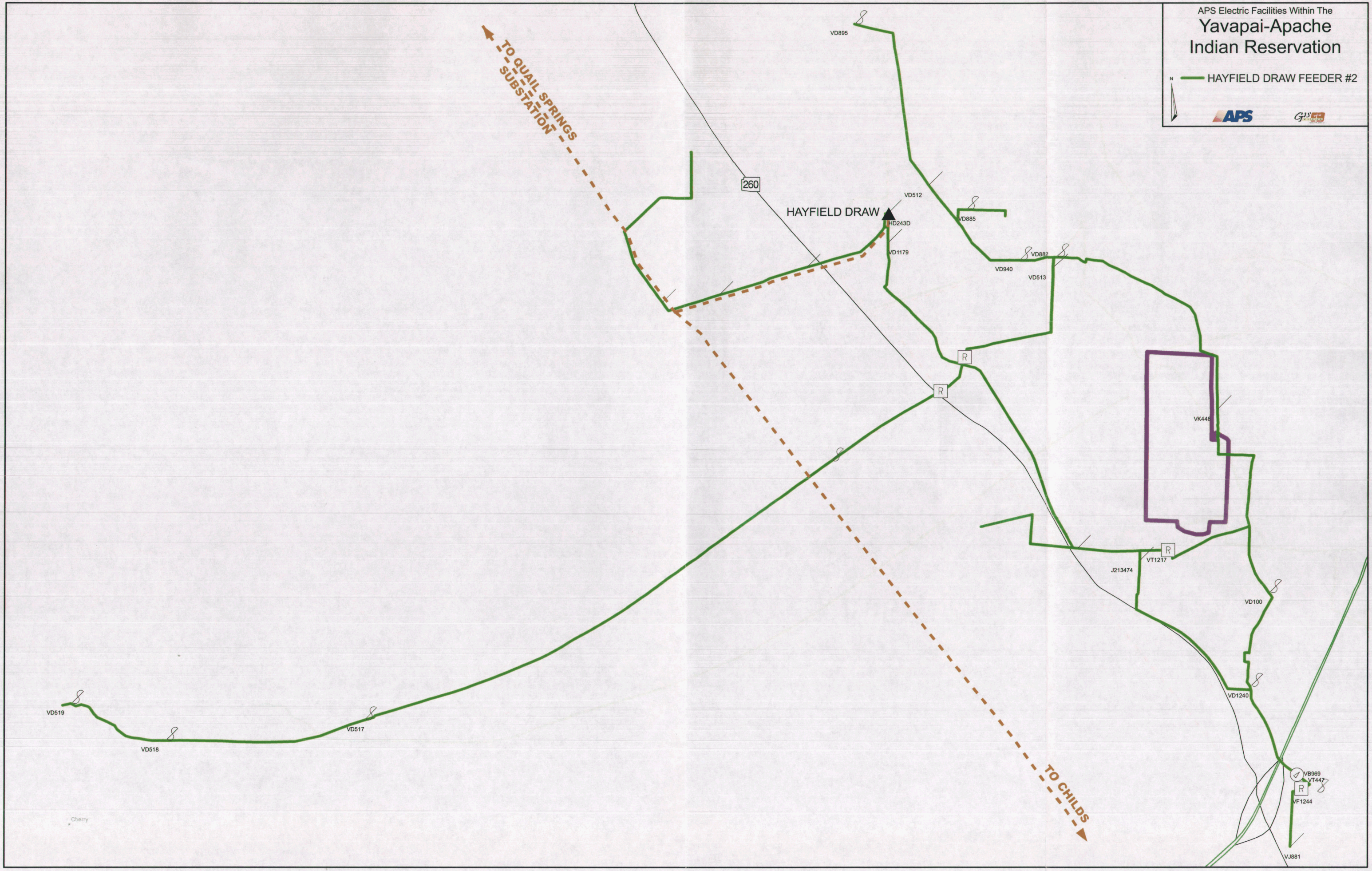
COTTONWOOD FEEDER #22




APS Electric Facilities Within The
Yavapai-Apache
Indian Reservation
GILA BEND FEEDER #22
APS
TOHONO O'ODHAM
INDIAN RESERVATION
San Lucy
246325
276685
246327
246320
246332
85
R
WR642
TO GILLESPIE
SUBSTATION
246289
202476
202482
276623
276626
TO BUNYAN
SUBSTATION
WD154
WTP952
GILA BEND
SUBSTATION
17
276652
210178
276658
277403
276654
276661
277402
276635
276640
MTP7844
1254765
277406
P303051
275643
276647
276649
275648
276659
P502971
277412
277419
WTP84
277418
277427
277421
1253576
1252540
276672
213260


NAVAJO INDIAN RESERVATION
8
F211717
89
TO BLACK MESA SUBSTATION
GM143D
GRAY MOUNTAIN
GM243D
TO SANDVIG SUBSTATION
APS Electric Facilities Within The
Navajo
Indian Reservation
GRAY MOUNTAIN FEEDER #1
N
APS


160
64
89
NAVAJO
INDIAN
RESERVATION
CAMERON
160
89
TO TONALEA
SUBSTATION
2962
HAMBLIN
HL143D
TO BLACK MESA
SUBSTATION
APS Electric Facilities Within The
Navajo
Indian Reservation
HAMBLIN FEEDER #1
N
APS


APS Electric Facilities Within The
Yavapai-Apache
Indian Reservation
HAYFIELD DRAW FEEDER #2
N
APS
TO QUAIL SPRINGS SUBSTATION
TO CHILDS
HAYFIELD DRAW
260
VD895
VD512
HD243D
VD1179
VD885
VD882
VD940
VD513
R
VK448
VT1217
J213474
VD100
VD1240
VB969
VT447
VF1244
VJ881
VD519
VD518
VD517
Cherry

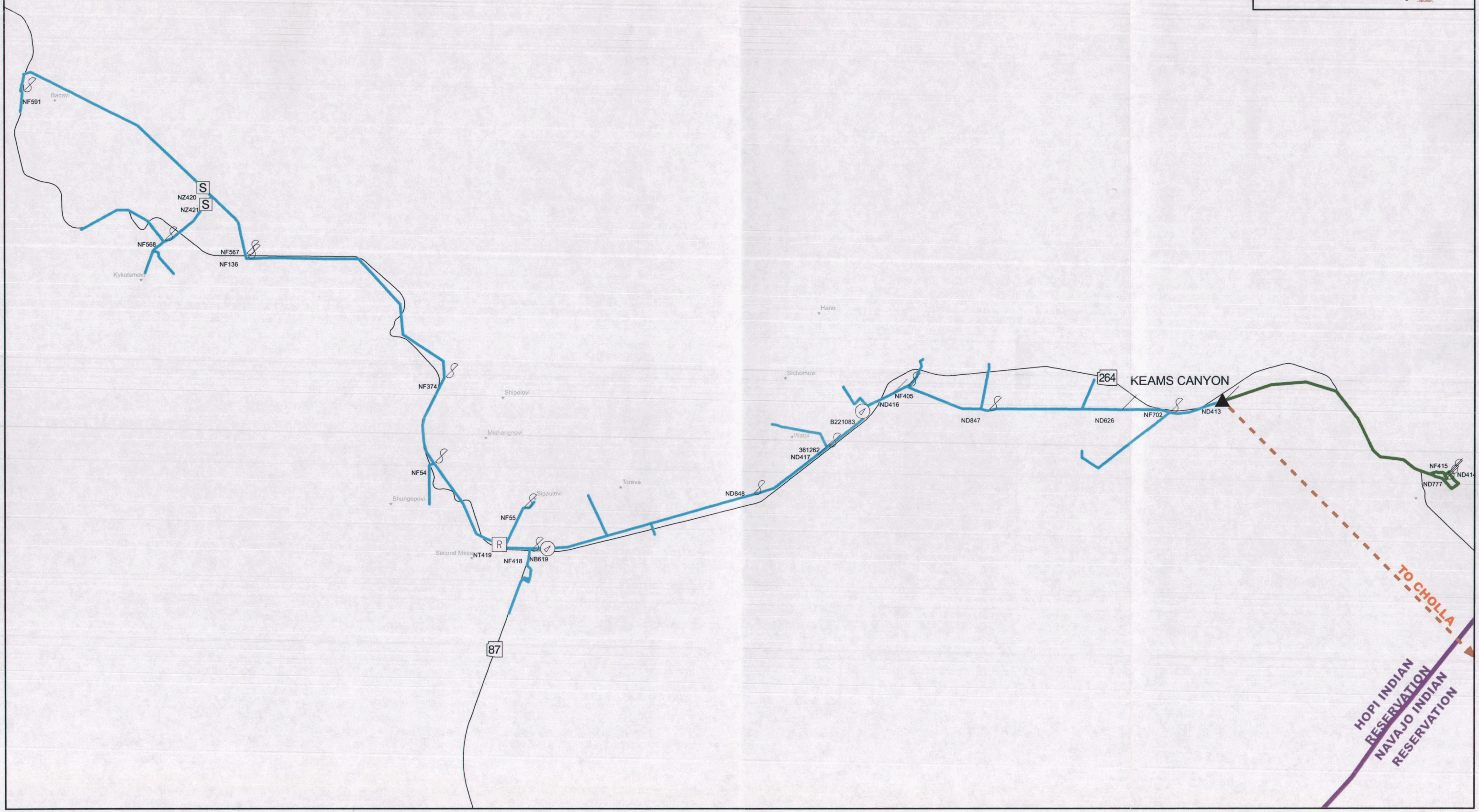
APS Electric Facilities Within The

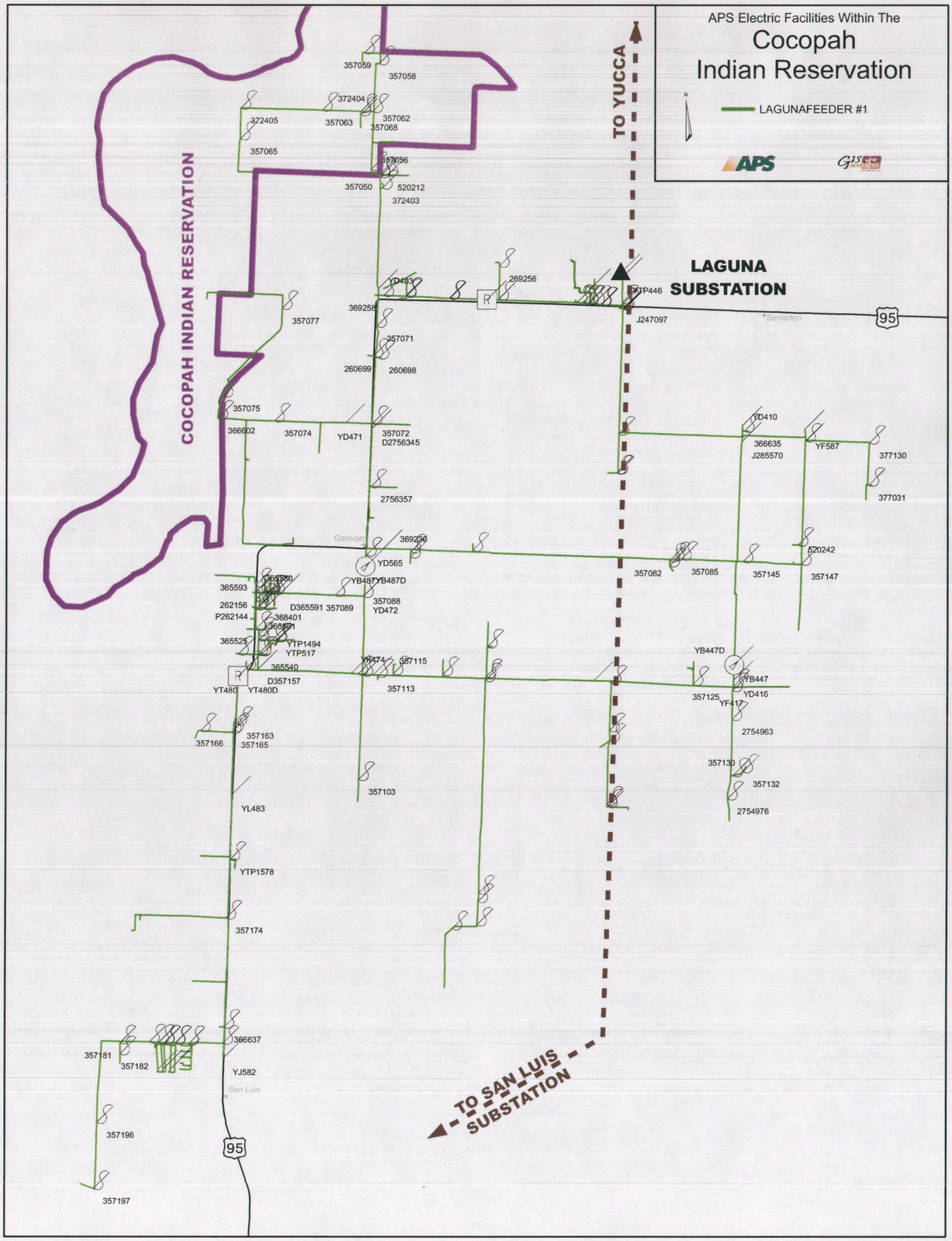
Hopi Indian Reservation

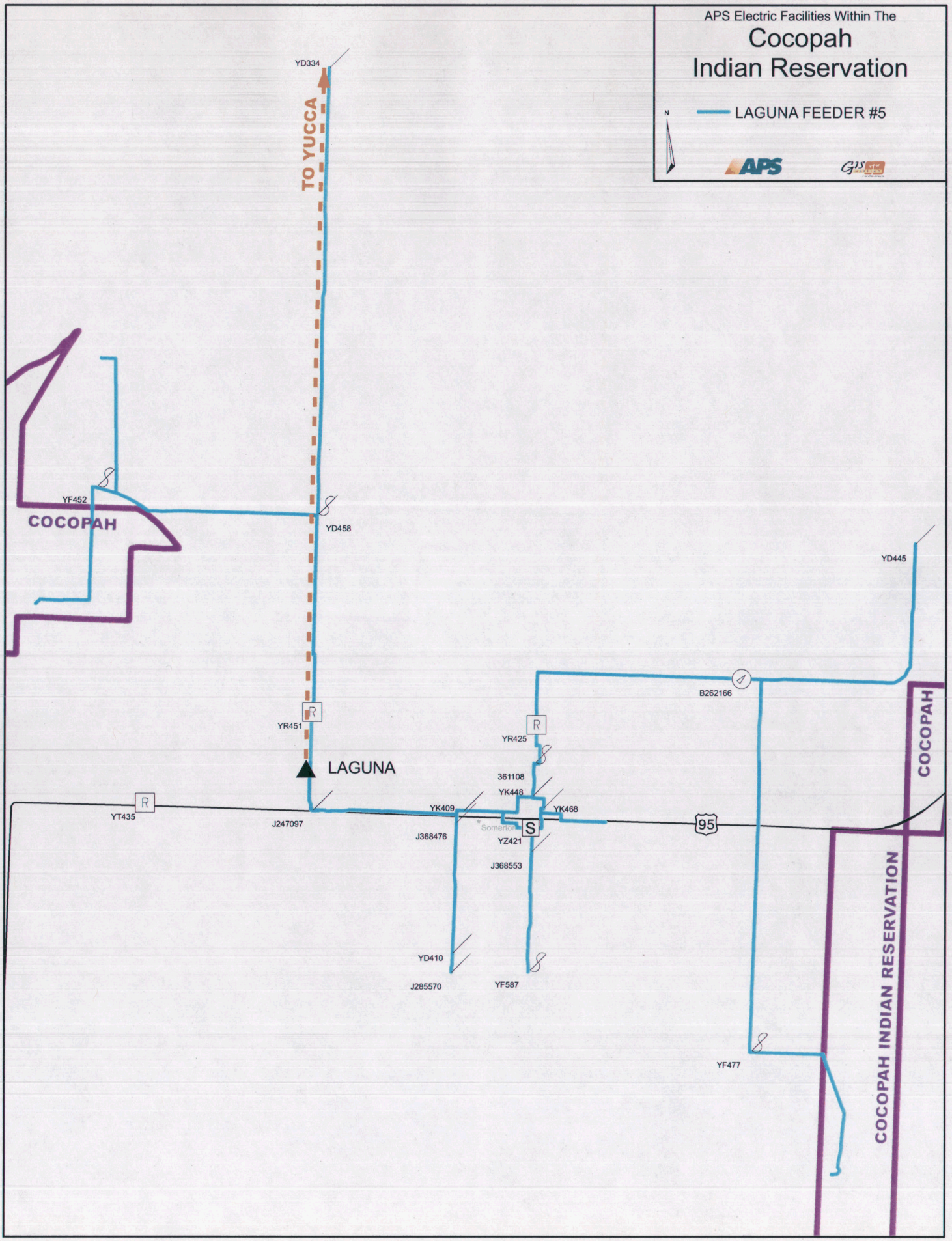
N

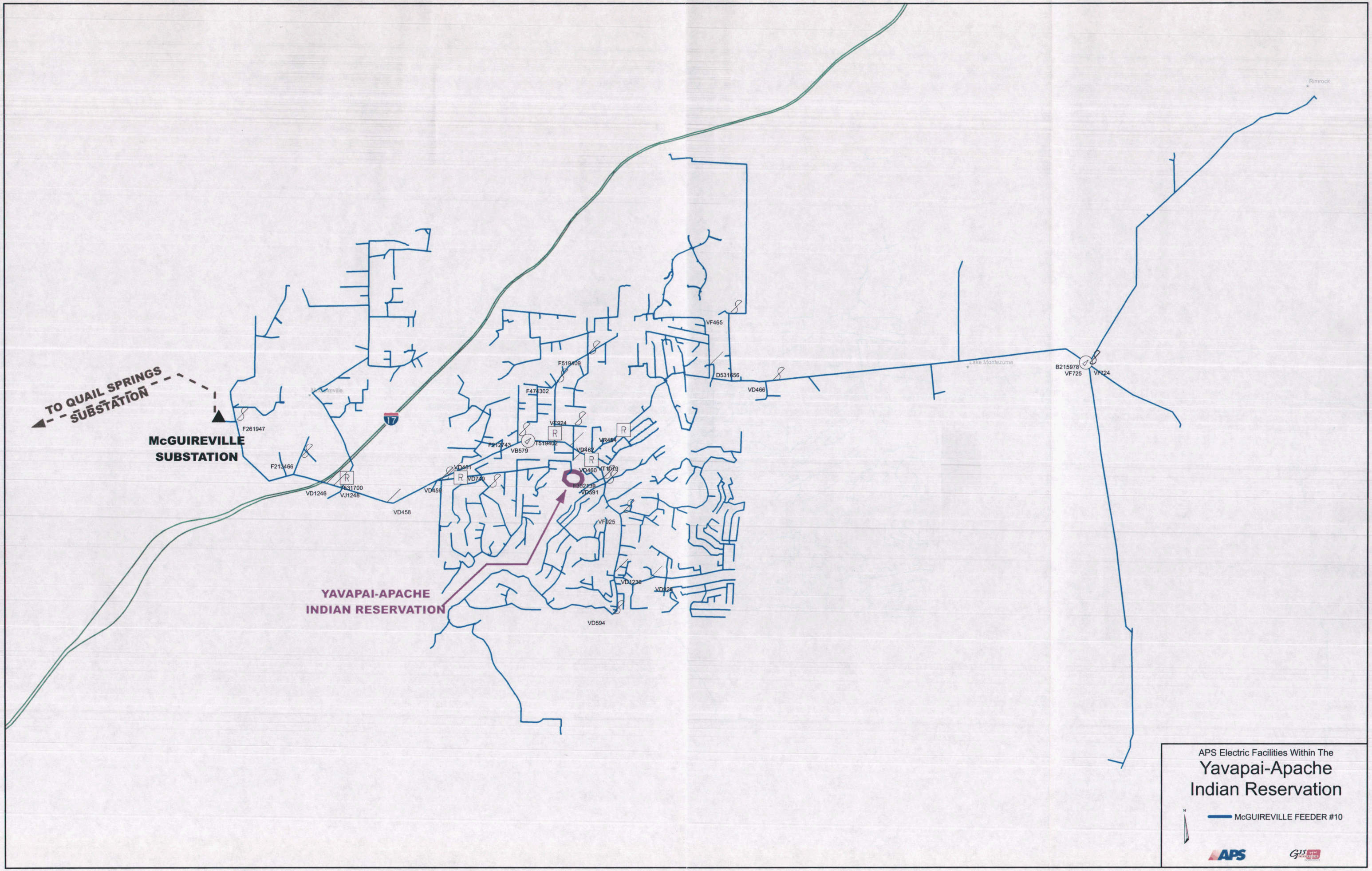
KEAMS CANYON FEEDER #3

KEAMS CANYON FEEDER #5




APS Electric Facilities Within The
Cocopah
Indian Reservation
LAGUNAFEEDER #1
APS
GIS
COCOPAH INDIAN RESERVATION
TO YUCCA
LAGUNA
SUBSTATION
TO SAN LUIS
SUBSTATION
Somerton
Gadsden
San Luis
95
357059
357058
372404
372405
357063
357062
357068
357065
357056
357050
520212
372403
YD493
269256
YTP446
J247097
369258
357077
357071
260699
260698
357075
366602
357074
YD471
357072
D2756345
2756357
YD410
366635
J285570
YF587
377130
377031
369230
YD565
YB487
YB487D
357088
YD472
357082
357085
357145
520242
357147
365593
365530
262156
D365591
357089
P262144
368401
365521
365525
YTP1494
YTP517
365540
D357157
YT480
YT480D
YK474
357115
357113
YB447D
YB447
YD416
357125
YF417
2754963
357163
357165
357166
357130
357132
2754976
357103
YL483
YTP1578
357174
366637
357181
357182
YJ582
357196
357197


APS Electric Facilities Within The
Cocopah
Indian Reservation
LAGUNA FEEDER #5
N
APS
YD334
TO YUCCA
YF452
COCOPAH
YD458
YD445
B262166
YR451
YR425
LAGUNA
361108
YK448
YK409
YK468
YT435
J247097
J368476
Somerton
YZ421
95
J368553
YD410
J285570
YF587
YF477
COCOPAH
COCOPAH INDIAN RESERVATION

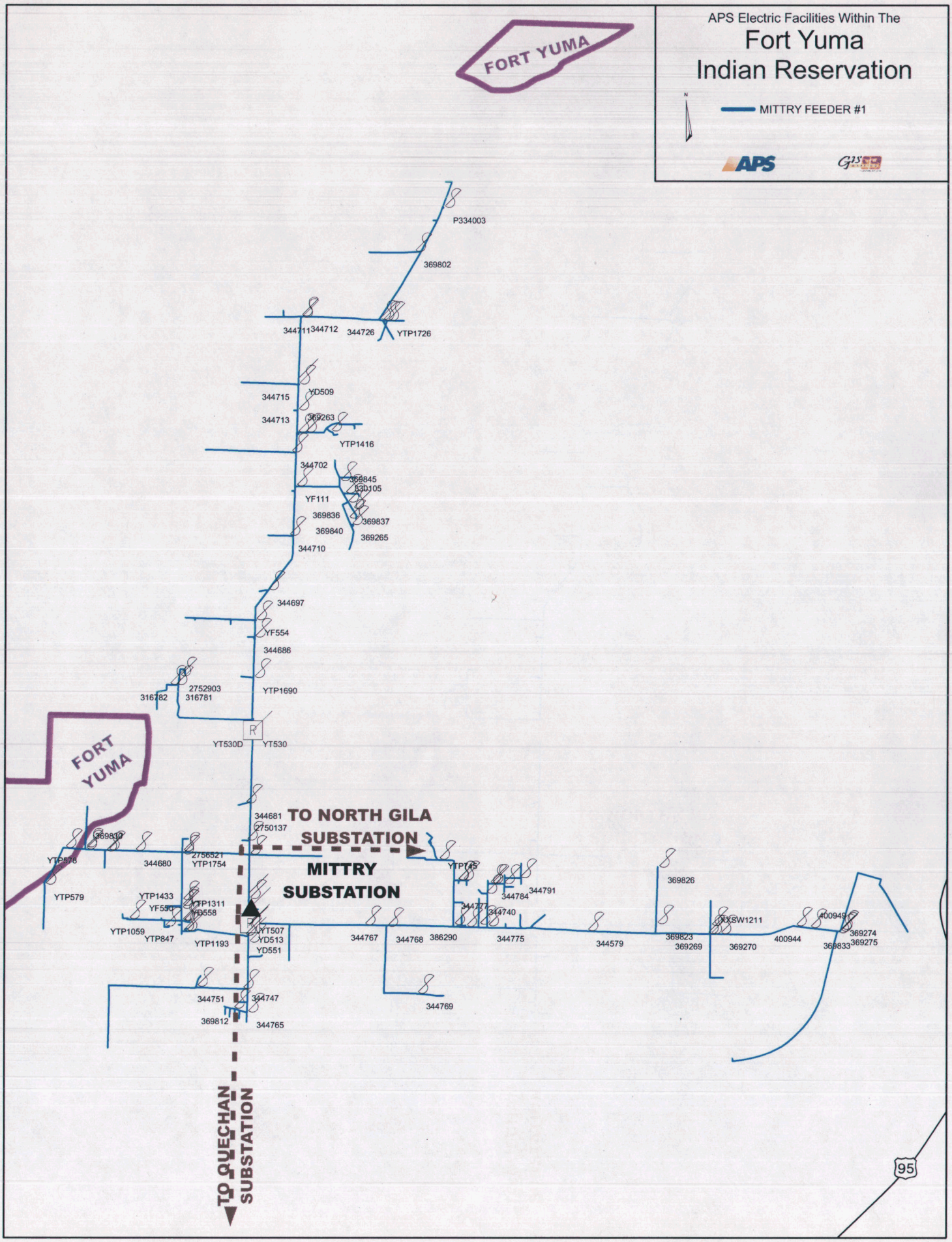

TO QUAIL SPRINGS SUBSTATION
McGUIREVILLE SUBSTATION
YAVAPAI-APACHE INDIAN RESERVATION
Rimrock
Lake Montezuma
17
F261947
F213466
VD1246
F631700
VJ1248
VD458
VD459
VD461
VD749
F212743
VB579
T519402
F519109
F474302
VF924
VD462
VR464
VD460
T1079
F362139
VD591
VF465
D531656
VD466
B215978
VF725
VF724
VF925
VD1236
VD926
VD594
APS Electric Facilities Within The
Yavapai-Apache
Indian Reservation
McGUIREVILLE FEEDER #10
APS

TO QUAIL SPRINGS SUBSTATION
McGUIREVILLE
McGuireville
VD1246
VJ1248
17
F264722
VJ455
VF456
VD457
Middle Verde
YAVAPAI-APACHE INDIAN RESERVATION
VJ1268
R
VT454
APS Electric Facilities Within The
Yavapai-Apache Indian Reservation
N
McGUIREVILLE FEEDER #14
APS

APS Electric Facilities Within The

Fort Yuma Indian Reservation

MITTRY FEEDER #1



APS Electric Facilities Within The

Gila River Indian Reservation

PAPAGO FEEDER #9

PAPAGO FEEDER #11

APS

GIS

GILA RIVER INDIAN RESERVATION

AK-CHIN INDIAN RESERVATION

NON-APS PRIMARY CONDUCTOR

PAPAGO SUBSTATION

TO MARICOPA SUBSTATION

NON-APS PRIMARY CONDUCTOR

PTP64
326598
PB100
326594
520266
301171
301165
324836
PTP585
PF588
352228
503367
PTP128
301146
301022
302607
301041
301095
301034
301039
352227
301098
329209
326461
301181
326421
326426
300592
P309348
300598
301133
Ak Chin
329205
326495
PTP728
326502
326562
326506
PTP600
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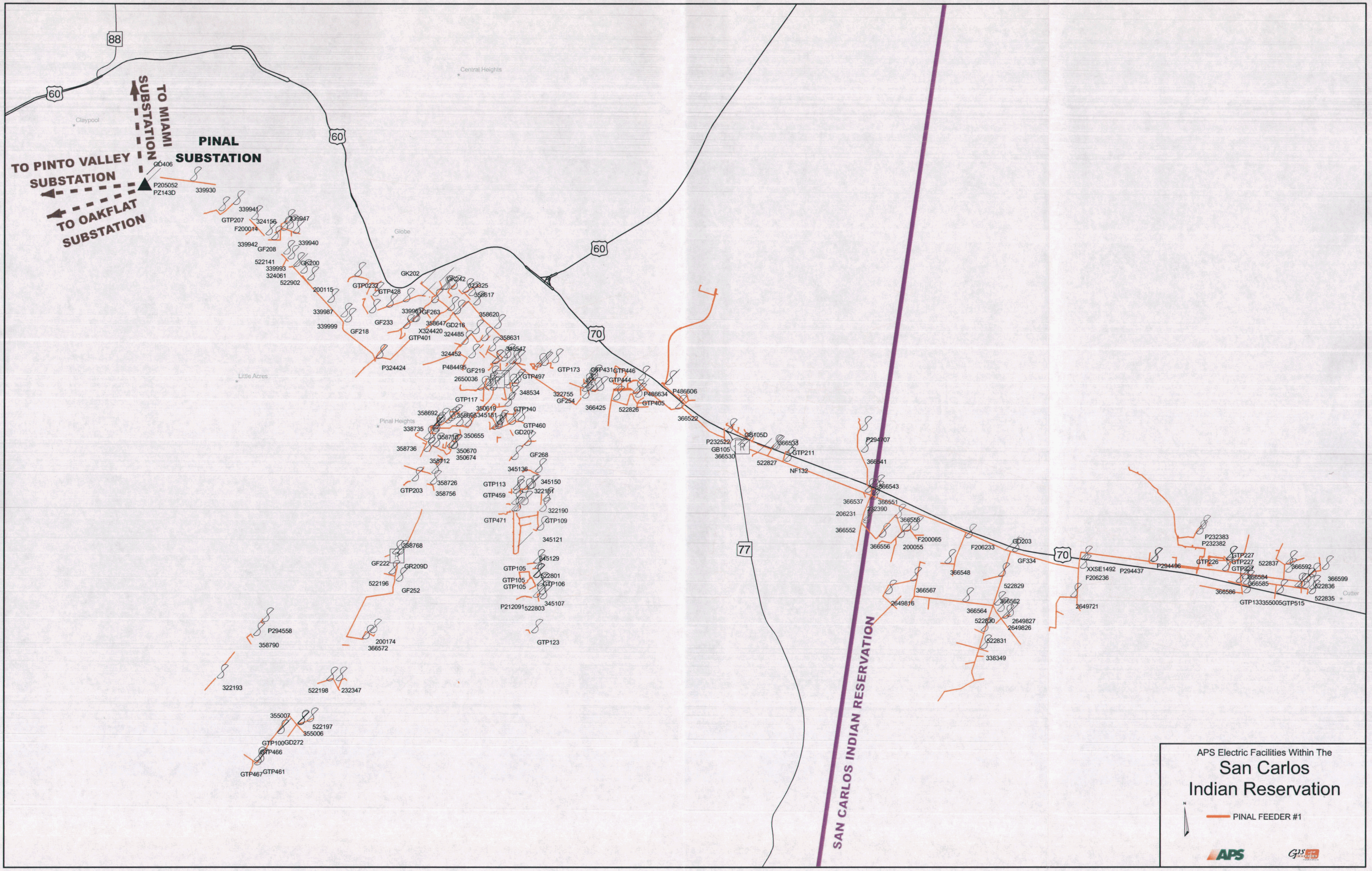
326527
326530
2501782
PD065
326536
PTP604
PTP603
PD506
326750
2503240


APS Electric Facilities Within The
San Carlos
Indian Reservation
PINAL FEEDER #1
PINAL SUBSTATION
TO MIAMI SUBSTATION
TO PINTO VALLEY SUBSTATION
TO OAKFLAT SUBSTATION
SAN CARLOS INDIAN RESERVATION
Claypool
Central Heights
Globe
Little Acres
Pinal Heights
Cutter
88
60
70
77
GD406
P205052
PZ143D
339930
339941
GTP207
324156
339947
F200014
339942
GF208
339940
522141
339993
324061
522902
GK200
200115
GTP0237
GTP428
GK202
GK242
323325
358617
339987
339999
GF218
GF233
339967
GF263
358647
GD216
X324420
GTP401
324485
358620
358631
348547
324452
P324424
P484495
GF219
2650036
GTP497
GTP173
GTP431
GTP446
GTP444
348534
322755
GF254
366425
522826
P486634
P486606
GTP405
GTP117
350619
GTP140
358692
358695
345181
338735
GTP460
GD207
358710
350655
358736
350670
350674
358712
GF268
345136
358726
358756
GTP203
GTP113
GTP459
345150
322167
322190
GTP471
GTP109
345121
358768
GF222
GR209D
522196
GF252
GTP105
345129
522801
GTP106
P212091
522803
345107
GTP123
P294558
358790
200174
366572
322193
522198
232347
355007
522197
355006
GTP100
GD272
GTP466
GTP467
GTP461
366522
P232522
GB105
366530
GD105D
366533
GTP211
522827
NF132
P294407
366541
366543
366537
366551
206231
232390
366552
366556
366555
F200065
200055
F206233
GD203
GF334
366548
366567
2649816
522829
366562
366564
522830
2649827
2649826
522831
338349
XXSE1492
F206236
P294437
2649721
P232383
P232382
GTP226
GTP227
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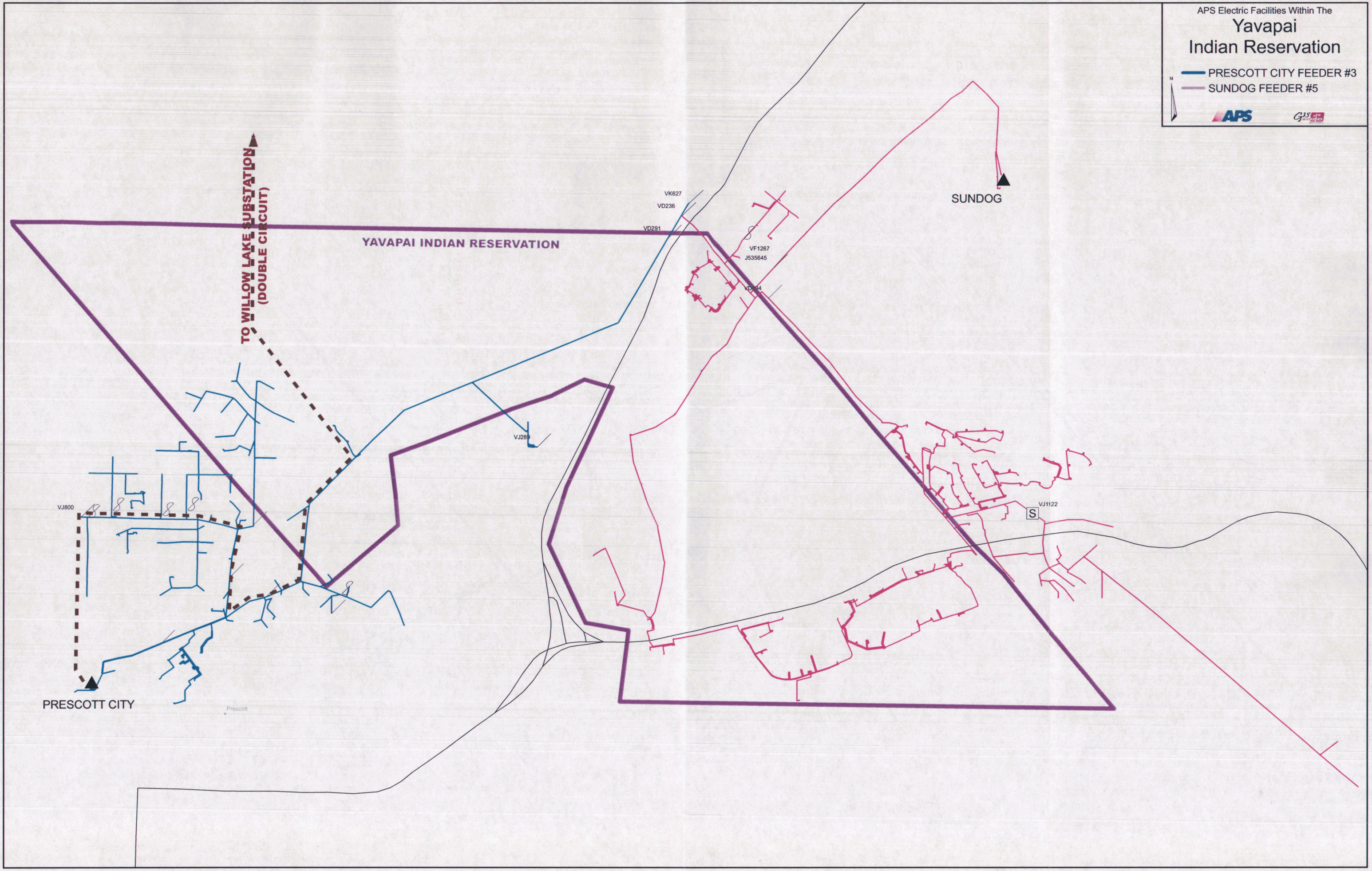
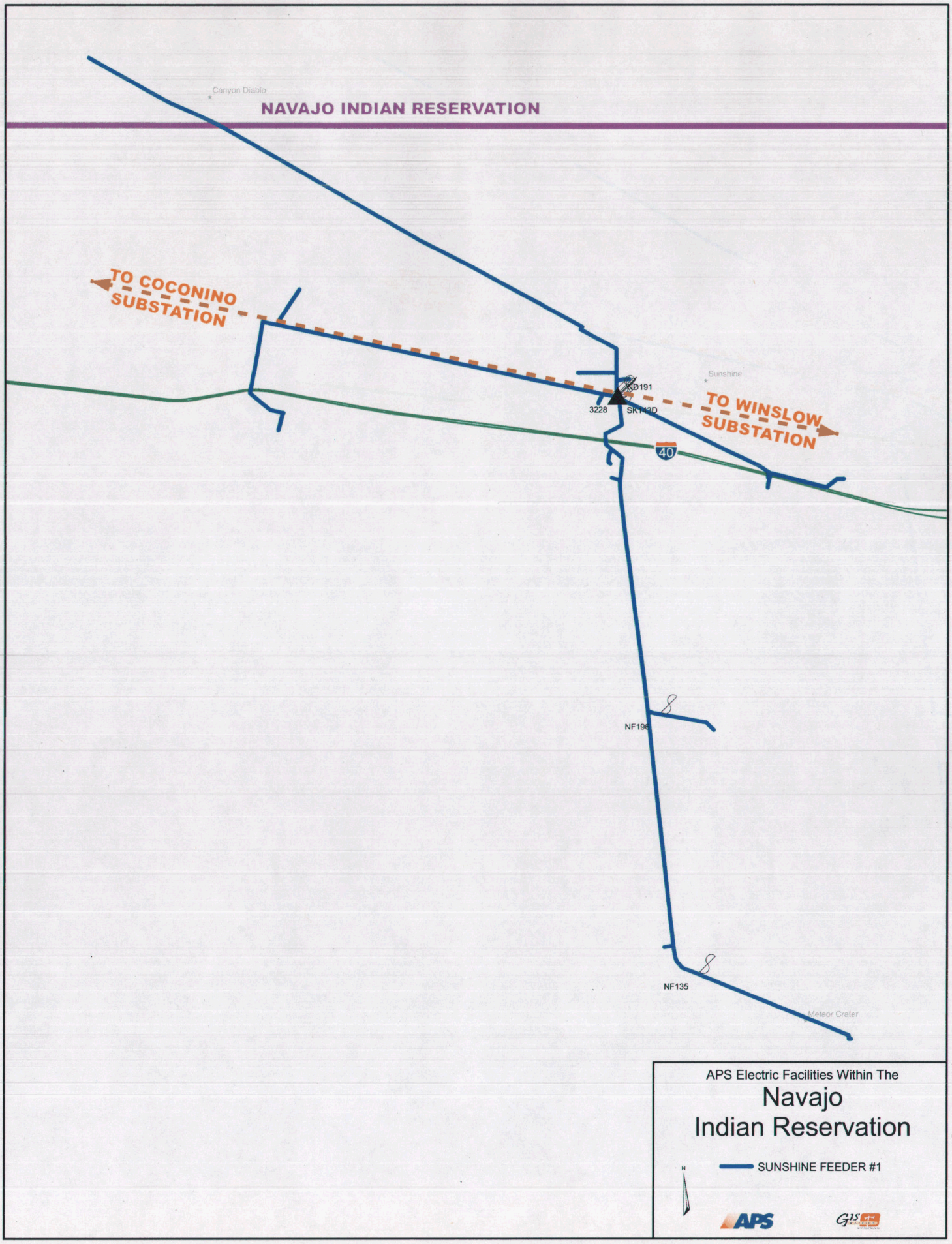
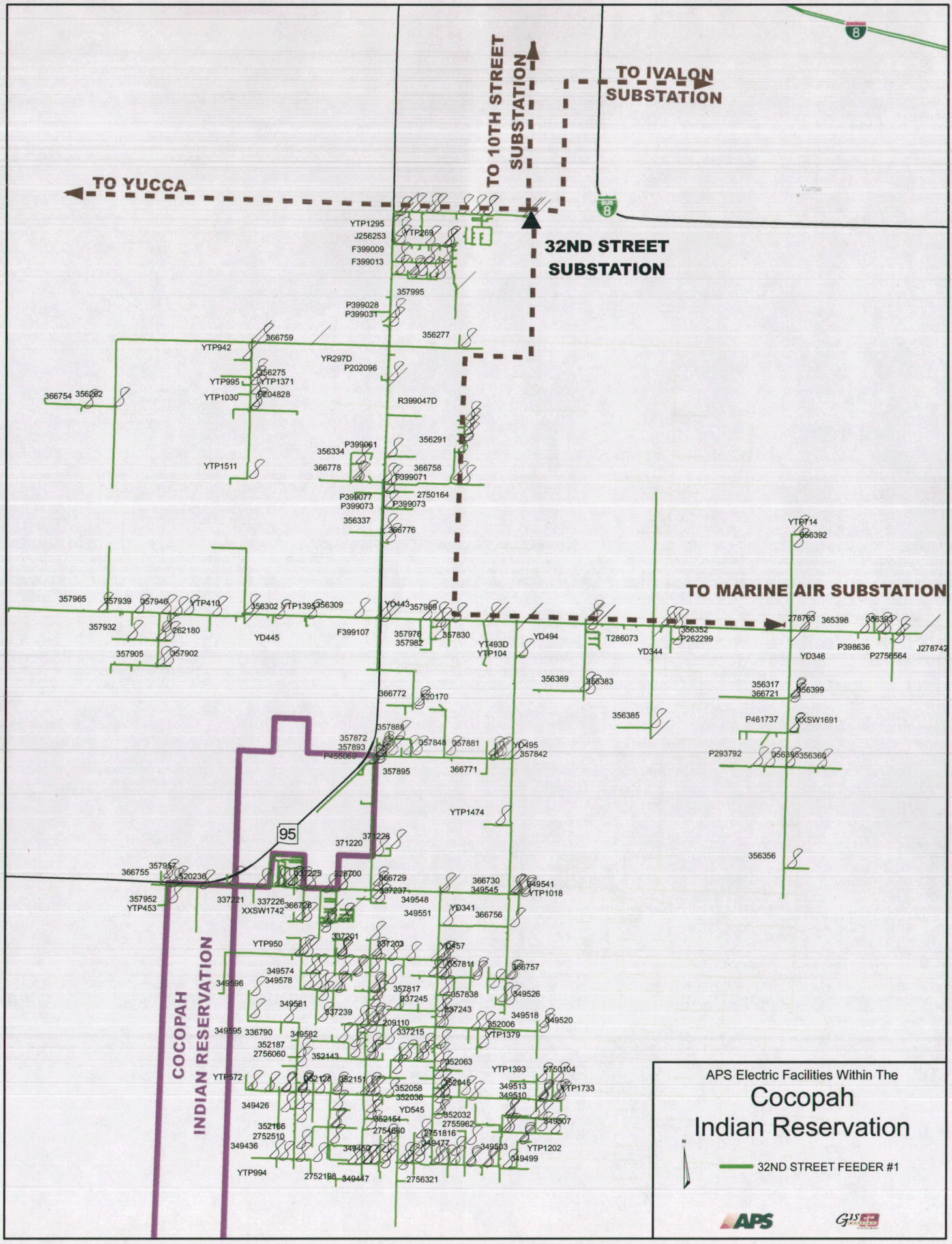
522835
GTP133
355005
GTP515


APS Electric Facilities Within The
Yavapai
Indian Reservation
PRESCOTT CITY FEEDER #3
SUNDOG FEEDER #5
APS
TO WILLOW LAKE SUBSTATION
(DOUBLE CIRCUIT)
YAVAPAI INDIAN RESERVATION
SUNDOG
VK627
VD236
VD291
VF1267
J535645
VD894
VJ289
VJ800
VJ1122
S
PRESCOTT CITY
Prescott


Canyon Diablo
NAVAJO INDIAN RESERVATION
TO COCONINO SUBSTATION
Sunshine
ND191
3228
SK192D
TO WINSLOW SUBSTATION
40
NF196
NF135
Meteor Crater
APS Electric Facilities Within The
Navajo
Indian Reservation
SUNSHINE FEEDER #1
N
APS


TO YUCCA
TO 10TH STREET SUBSTATION
TO IVALON SUBSTATION
32ND STREET SUBSTATION
TO MARINE AIR SUBSTATION
COCOPAH INDIAN RESERVATION
Yuma
8
95
YTP1295
J256253
F399009
F399013
YTP269
357995
P399028
P399031
356277
366759
YTP942
YR297D
P202096
356275
YTP995
YTP1371
366754
356282
YTP1030
P204828
R399047D
356291
P399061
356334
YTP1511
366778
366758
P399071
P399077
P399073
2750164
P399073
356337
366776
YTP714
356392
357965
357939
357946
YTP410
356302
YTP1395
356309
YD443
357988
357932
262180
YD445
F399107
357976
357982
357830
YT493D
YTP104
YD494
T286073
YD344
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P262299
278763
365398
356393
P398636
P2756564
J278742
YD346
357905
357902
356389
356383
356317
366721
356399
366772
520170
356385
P461737
XXSW1691
357885
357872
357893
P455069
357848
357881
YD495
357842
P293792
356395
356364
357895
366771
YTP1474
371228
371220
356356
366755
357957
520236
337223
228700
366729
337237
366730
349545
349541
YTP1018
357952
YTP453
337221
337226
XXSW1742
366728
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349551
YD341
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YTP950
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YD457
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337239
337243
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YTP1379
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352187
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352063
YTP572
352128
352151
352058
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YTP1733
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2754860
2751816
349477
349503
YTP1202
349436
349450
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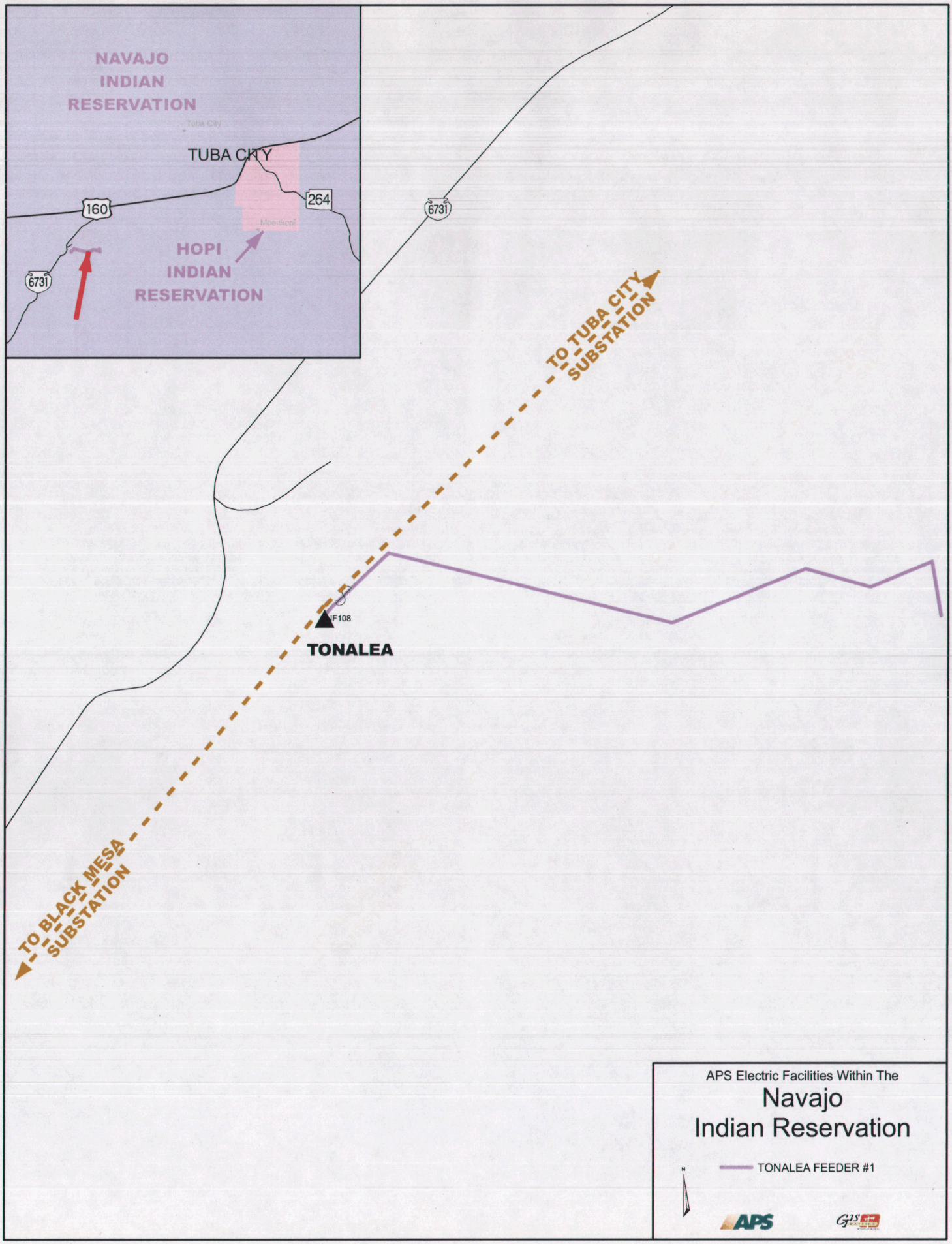
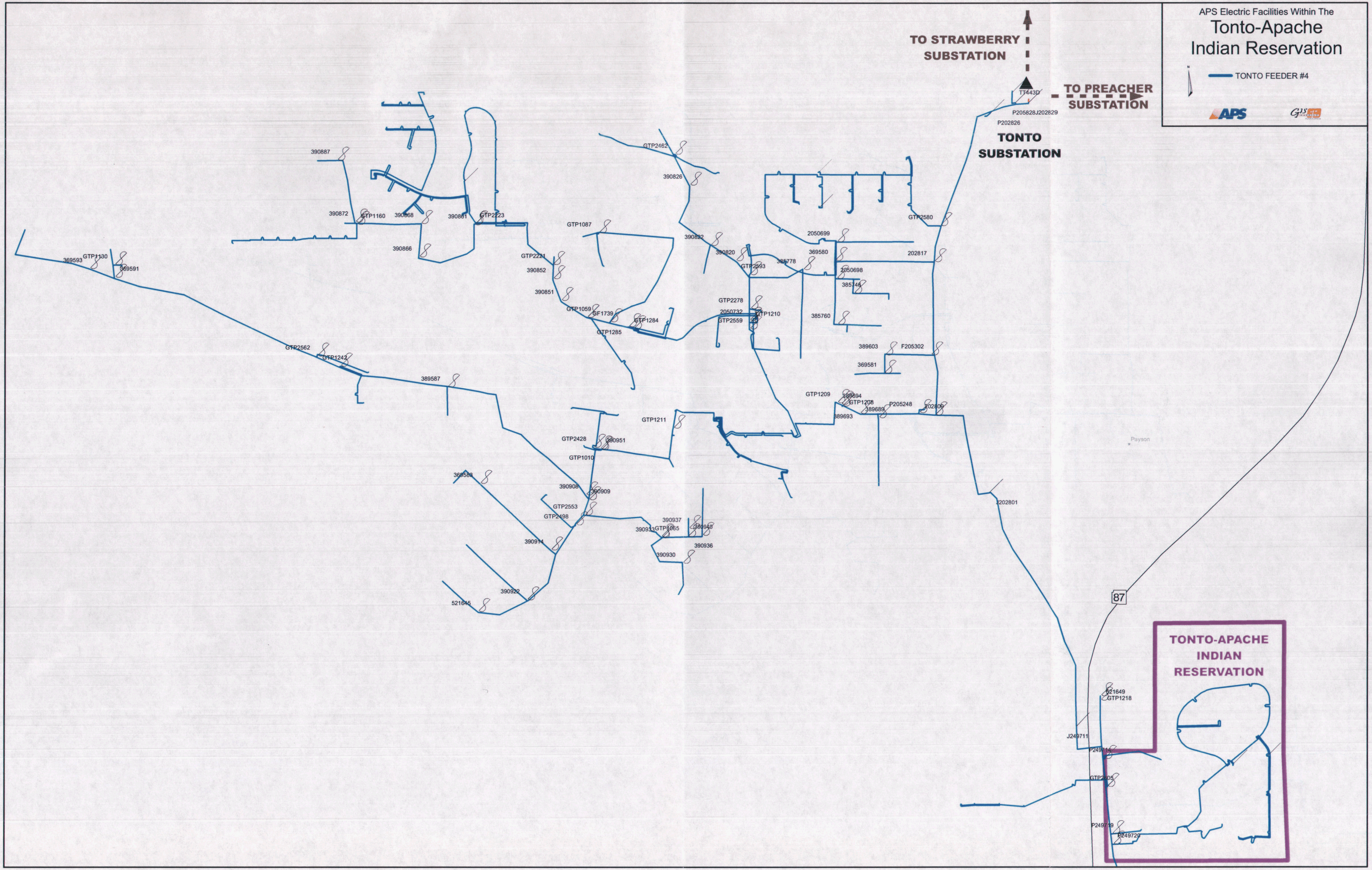
APS Electric Facilities Within The
Cocopah
Indian Reservation
32ND STREET FEEDER #1
APS
GIS


NAVAJO
INDIAN
RESERVATION
Tuba City
TUBA CITY
160
264
6731
Moenkopi
HOPI
INDIAN
RESERVATION
6731
TO TUBA CITY
SUBSTATION
NF108
TONALEA
TO BLACK MESA
SUBSTATION
APS Electric Facilities Within The
Navajo
Indian Reservation
TONALEA FEEDER #1
N
APS
GIS

APS Electric Facilities Within The

Tonto-Apache Indian Reservation

TONTO FEEDER #4



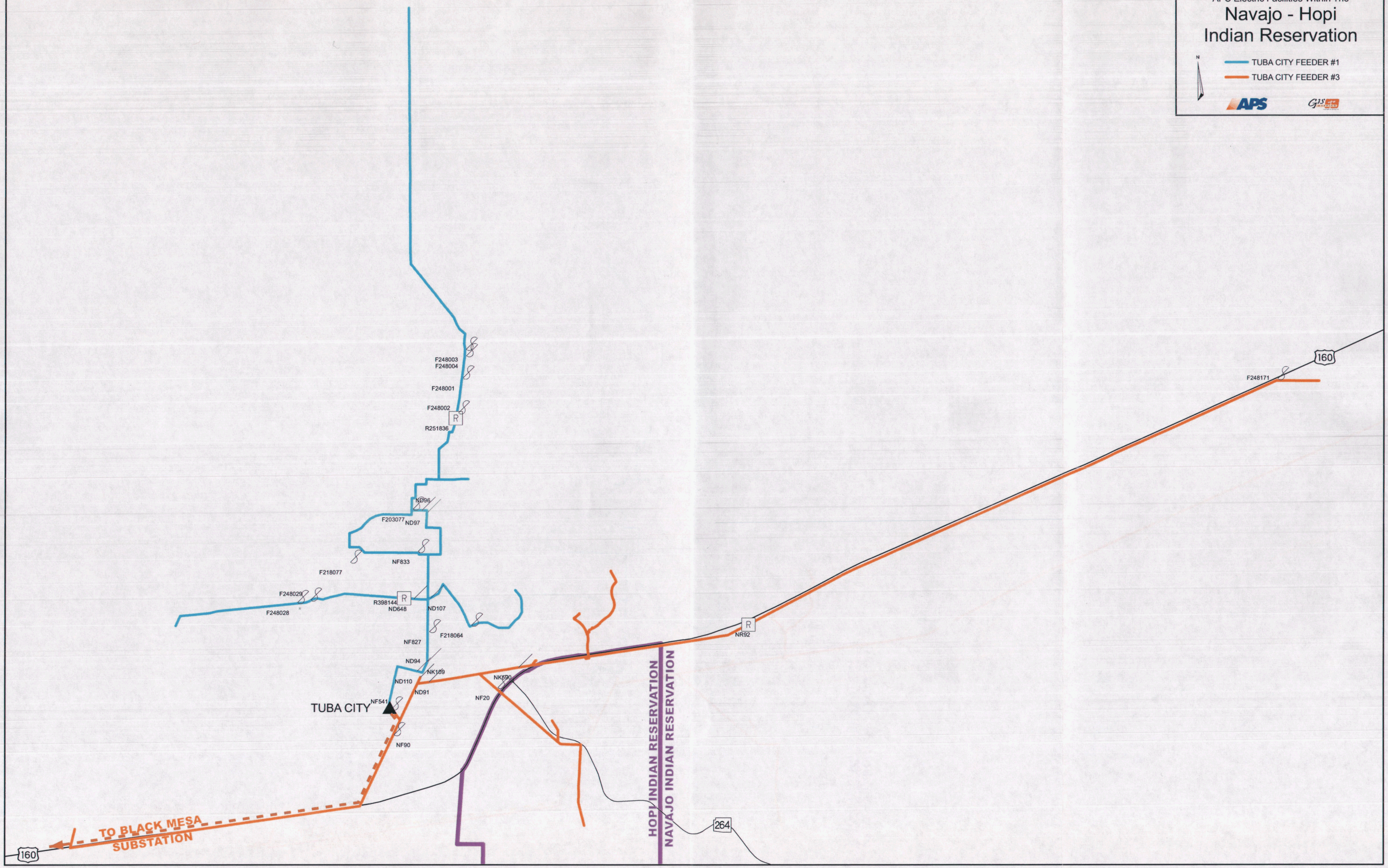
APS Electric Facilities Within The

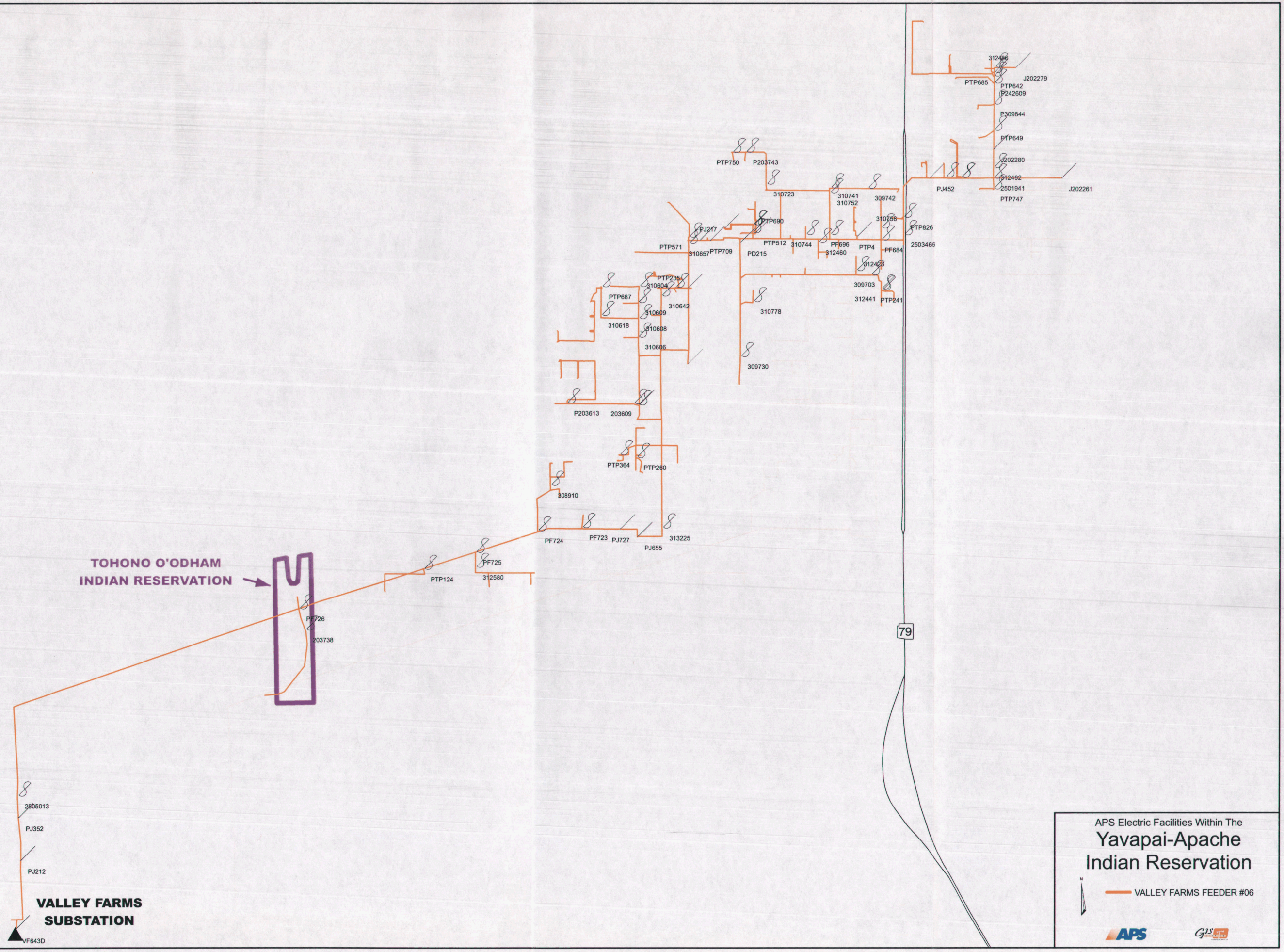
Navajo - Hopi Indian Reservation

N

TUBA CITY FEEDER #1

TUBA CITY FEEDER #3

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P309844
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312492
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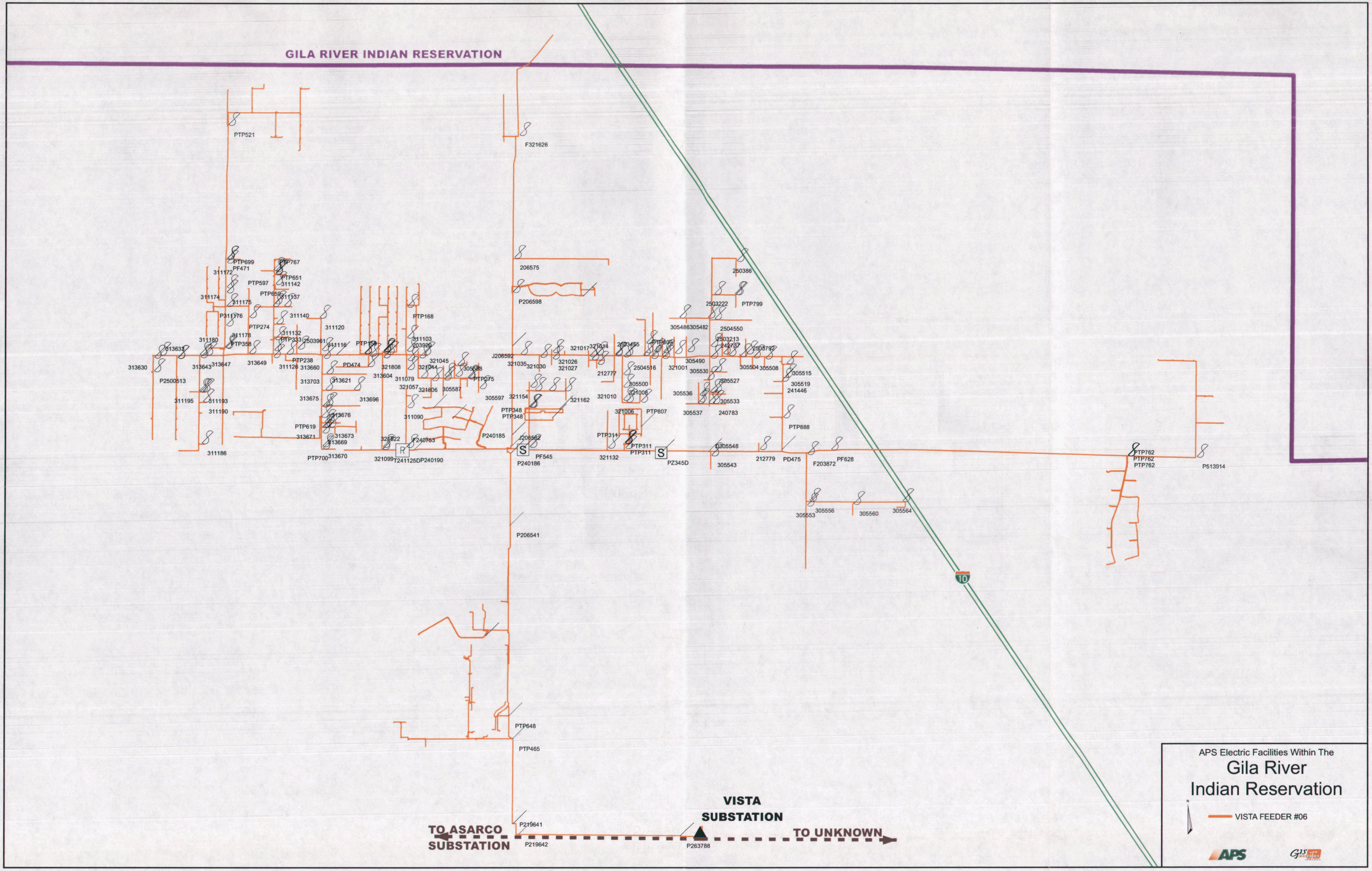
PJ452
PTP747
PTP750
P203743
310723
310741
310752
309742
310758
PTP826
2503466
PTP690
PJ217
PTP512
310744
PF696
312460
PTP4
PF684
PTP571
310657
PTP709
PD215
312428
PTP236
310604
309703
312441
PTP241
PTP687
310609
310642
310778
310618
310608
310606
309730
P203613
203609
PTP364
PTP260
308910
PF724
PF723
PJ727
PJ655
313225
PF725
312580
PTP124
TOHONO O'ODHAM
INDIAN RESERVATION
PF726
203738
79
2505013
PJ352
PJ212
VALLEY FARMS
SUBSTATION
VF643D
APS Electric Facilities Within The
Yavapai-Apache
Indian Reservation
N
VALLEY FARMS FEEDER #06
APS


GILA RIVER INDIAN RESERVATION
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206575
P206598
250386
PTP799
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2503213
242767
2503792
PTP699
PF471
311172
PTP767
PTP651
311142
PTP597
PTP659
311137
311174
311175
P311176
311140
PTP274
311132
PTP333
2503961
311120
PTP168
311178
PTP358
311180
313633
313630
313643
313647
313649
311116
PTP158
311103
203920
321045
321044
305588
PTP075
J206592
321035
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321026
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321017
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PTP803
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305530
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321001
305504
305508
305515
305519
241446
212777
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321006
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305527
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305537
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PTP807
PTP888
P2500513
PD474
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313703
313604
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321057
321806
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321162
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PTP348
PTP348
311195
311193
311190
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PTP311
PTP311
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PD475
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PF628
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PTP762
PTP762
P513914
311186
PTP619
313676
313671
313673
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PF545
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PZ345D
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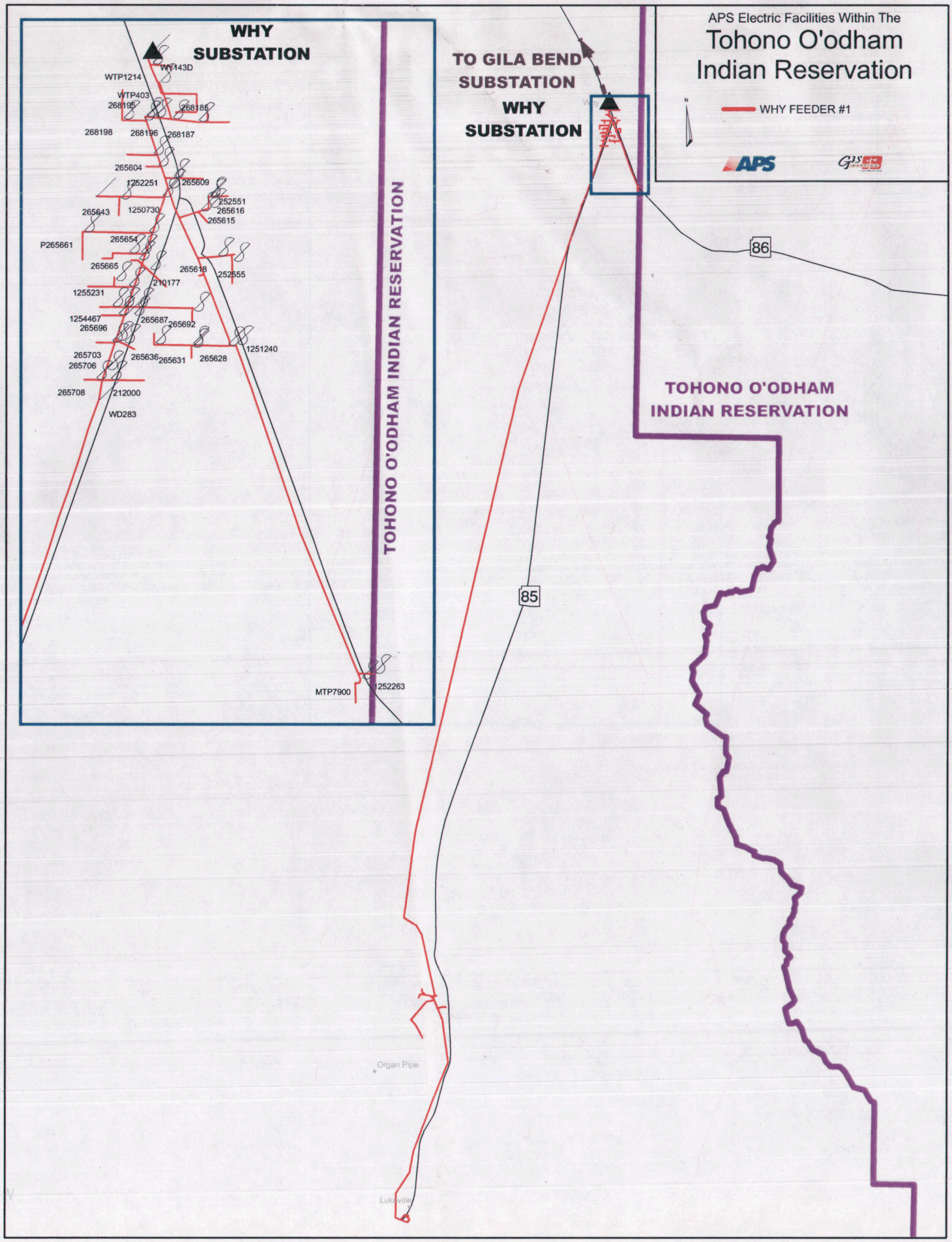
305556
305560
305564
P206541
PTP648
PTP465
P219641
P219642
P263788
VISTA
SUBSTATION
TO ASARCO
SUBSTATION
TO UNKNOWN
10
APS Electric Facilities Within The
Gila River
Indian Reservation
VISTA FEEDER #06
APS


APS Electric Facilities Within The
Tohono O'odham
Indian Reservation
WHY FEEDER #1
APS
WHY
SUBSTATION
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WTP1214
WTP403
268195
268185
268198
268196
268187
265604
1252251
265609
252551
265616
265615
265643
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265618
252555
210177
1255231
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265687
265692
265696
265703
265636
265631
265628
1251240
265706
265708
212000
WD283
MTP7900
1252263
TOHONO O'ODHAM INDIAN RESERVATION
TO GILA BEND
SUBSTATION
WHY
SUBSTATION
86
85
TOHONO O'ODHAM
INDIAN RESERVATION
Organ Pipe
Lukeville