ORIGINAL

Tucson Electric Power Company
P.O. Box 711, Tucson, AZ 85702
One South Church Avenue, Suite 200, Tucson, Arizona 85701

January 30, 2009

Docket Control
Arizona Corporation Commission
1200 West Washington Street
Phoenix, AZ 85007

Re: **Docket No. E-00000D-09-0020**

Docket Control:

Pursuant to Decision No. 70635, Docket No. E-00000D-07-0376, Tucson Electric Power Company ("TEP") hereby files the SATS long range study on behalf of all SATS participants. Per the "Request for a New Docket" filed in Docket No. E-00000D-07-0376 dated January 22, 2009, TEP is filing the SATS long range study in Docket No. E-00000D-09-0020.

Sincerely,

Jessica Bryne

Jessica Bryne
Regulatory Services

cc: Ernest Johnson, ACC
Prem Bahl, ACC
Compliance, ACC

RECEIVED
2009 FEB -2 P 2:30
AZ CORP COMMISSION
DOCKET CONTROL

Arizona Corporation Commission
DOCKETED
FEB -2 2009
DOCKETED BY

Southeast Arizona Transmission Study Report

January 13, 2009

TABLE OF CONTENTS

1. Executive Summary 3

2. Introduction and Overview 22

3. Participating Organizations 24

4. Definitions 30

5. Study Process 32

6. Study Goals and Objectives 35

7. Study Scope and Schedule 36

8. Study Criteria 43

9. Study Methodology and Assumptions 46

10. Saturated Load Study 53

11. Load Forecast 55

12. Scenarios 60

13. Existing Generation and Maximum Unit Commitment 64

14. Existing Transmission 66

15. Characteristics of SATS Transmission System 75

15.1. Greenlee to Vail EHV and 230kV Corridor Area 76

15.2. South of Tucson Area 78

15.3. West of Tucson Area 80

16. Potential Alternative Projects 81

17. WESTERN 115kV Transmission Corridor 89

18. Southwest Public Power Resource (SPPR) "Three Terminal Plan" 92

19. Long-Term SATS and Individual EHV Transmission Provider Strategies 93

19.1. Project Assumptions 95

19.2. Strategy A 97

19.3. Strategy B 99

19.4. Strategy C 100

19.5. Strategy D 102

19.6. Strategy E 103

19.7. Strategy F 103

20. TEP 138kV Future System Strategy 105

21. Findings from Power Flow Analyses 143

22. Cochise County 154

23. Sensitivity Analysis 171

24. Economic Analysis 173

25. Developing a Flexible Plan 173

26. List of Projects for Ten Year Planning Horizon 176

27. Conclusions 188

28. Recommendations and 2009 SATS Study Plan 189

29. Appendices 190

1. Executive Summary

SATS Committee Overview

The initiative to create the Southeast Arizona Transmission System (SATS) study group was based upon the common interests of Tucson Electric Power (TEP) and Southwest

Transmission Cooperative (SWTC). In light of the integrated nature of their respective transmission systems there was an obvious benefit to be achieved from coordination of their study and planning efforts. Meetings were held between August and December of 2006 at which a number of entities expressed interest in pursuing a coordinated planning effort for the entire southeast Arizona region. SATS became an official subcommittee of the Southwest Area Transmission (SWAT) subregional planning committee in October of 2006 and its first study plan was approved by SWAT in May of 2007.

To date nineteen entities have participated in the SATS study effort. These participants have included transmission service providers, distribution cooperatives, federal and state agencies, developers, and a military reservation. The following table lists the SATS study participants.

Acciona Energy	Arizona Corporation Commission
Arizona Power Authority	Arizona Independent Scheduling Administrator
Arizona Public Service	Central Arizona Project
El Paso Electric	Environmental Planning Group
Fort Huachuca	New Mexico Renewable Energy Transmission Authority
Public Service of New Mexico	Southwest Transmission Cooperative
Southwestern Power Group	Sulphur Springs Valley Elec. Coop.
SunZia Transmission Project	Trico Electric Cooperative
Tucson Electric Power Company	U.S. Bureau of Reclamation
Western Area Power Administration	Western States Energy Solutions

Table of SATS Participants

The SATS study area includes all, or portions, of Cochise, Graham, Pima, Pinal, and Santa Cruz counties. Within this region are transmission, sub-transmission, and generation facilities owned and operated by various entities including Arizona Public Service (APS), Central Arizona Project (CAP), Sulphur Springs Valley Electric Cooperative (SSVEC), Trico Electric Cooperative (Trico), Unisource Energy (UNSE) and Western Area Power Administration (WESTERN), in addition to SWTC and TEP. There are also possible generation and transmission project proponents within the area, such as the Bowie Power Station generation project and the SunZia Southwest

Transmission Project. The following map provides an illustration of the SATS study area.

SATS Study Footprint

SATS Study Overview

The SATS study process has been a collaborative effort that was conducted in an open and transparent stakeholder forum. Southeast Arizona is a rapidly growing area with a pressing need to increase local area Load Serving Capability from remote resources. Opportunities to maximize the regional value of transmission investment to import remote resources are being explored as they become known. In addition, the group recognizes the importance of actively evaluating impacts of potential EHV transmission and remote resource projects that are under consideration to transmit large quantities of power through SATS. These projects are significant due to SATS' strategic location bordering Mexico, New Mexico and the high growth power markets north and west of the greater Tucson area. Renewable resources are implicitly considered as they are

anticipated to become an increasing portion of the remote resources under consideration to be transmitted into the SATS load pocket. The SATS group relies on information related to evolving efforts to transmit renewable energy into and through Southeast Arizona.

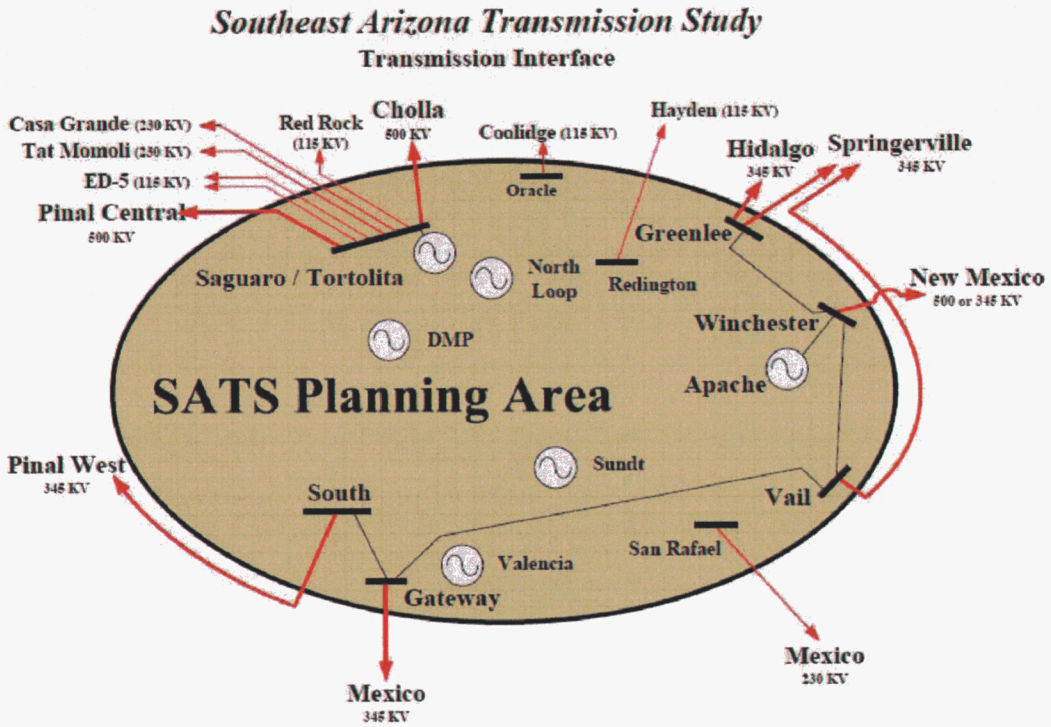
SATS goal is to have a 20 year transmission plan covering the entire SATS area assuming transmission and distribution facilities are owned and operated as a "single system". Key objectives include developing a transmission plan that:

- Provides reliable load serving capability while minimizing redundant transmission investment.
- Consists of alternative projects that offer mutual benefits, and therefore the lowest cost while minimizing aesthetic and environmental impacts.
- Responds to future uncertainties such as load forecast error, ability to site new transmission projects, decisions and timing for large generation and/or transmission projects, plus related technical or financial risk.
- Provides a sound basis for developing individual Transmission Provider long-range transmission plans.
- Establishes a planning process which facilitates ongoing assessment of future opportunities to further optimize long-range strategies.

The initial planning horizon for the SATS study spanned the twenty year time frame from 2007 to 2026. Load forecasts spanning this period were provided by each of the SATS load serving entities. In addition, a saturation load study was prepared by TEP for their service area which provided insights beyond the twenty year planning horizon. The primary purpose of the saturation study was to ensure that projects proposed for the twenty year planning horizon would continue to be technically and economically viable. Development of power flow base cases for 2010, 2016, 2026 and saturation was proposed. The purpose of 2010 was to assess projects for the three-to-five year time frame to determine which, if any, issues required resolution using short-term measures. A 2016 case was chosen based on availability of a SWAT case to develop a ten year case. Scope changes were made as the study effort progressed and preliminary saturation case results became available. As the study effort progressed there was a transition to development of improved models for the five, ten and twenty year planning horizons. A twenty year base case (2028) was prepared from the saturation case by

scaling loads down to approximately 75%, and an additional ten year (2018) analysis was based on a greater than 50% saturation case. (Note that percentages referenced to saturation apply only to TEP.)

The electrical interface between the SATS participants' facilities and external systems was defined to provide as much clarity as possible about which transmission systems affect the study area. This interface identifies the boundary between the long-range SATS planning model, and the external systems (for which modeling information was only available for ten years into the future). The SATS interface is illustrated in the following figure:



SATS Transmission Interface

Note that this diagram is intended to illustrate key transmission and/or generation interconnections without regard to transformation among voltage levels.

Planning standards, criteria and assumptions have a profound impact on the study

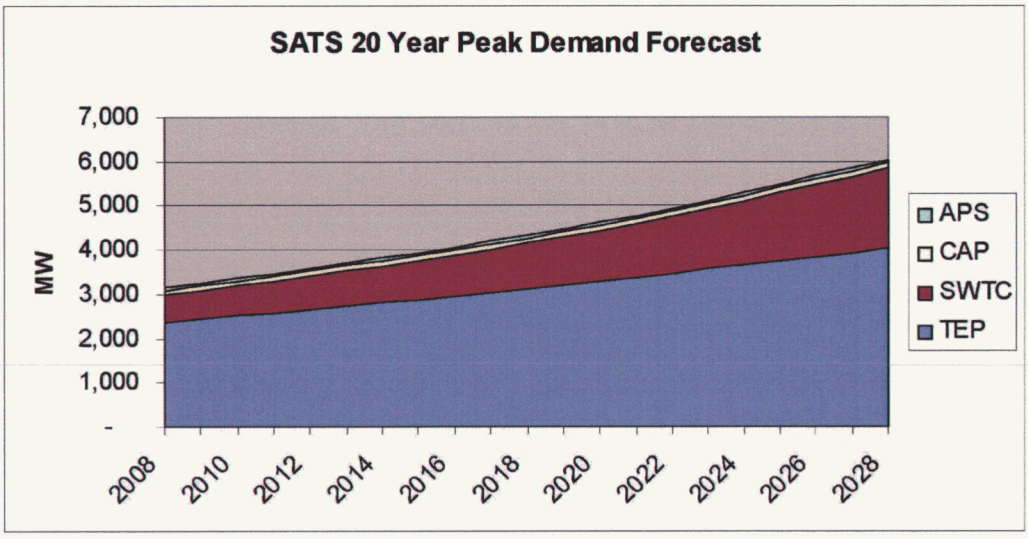
process, system performance evaluation and resulting planned upgrades. All of the SATS Participants agreed that NERC/WECC Planning Standards must be met. Therefore NERC and WECC Standards, with the effective date of April 1, 2005, existing as of the start of the SATS study were used in the analysis to determine the load serving capability of the SATS interconnected network. However, the studies accommodated variances between SWTC and TEP in their respective local criteria.

The SATS study is actually several coordinated studies designed to analyze and define the characteristics of the systems within the SATS footprint, and to determine the various options available to the companies. As a result of this approach each scenario or case has a separate set of assumptions. For example, concerns that exist today required study of sub-areas within the SATS footprint. These studies of local systems, such as in Cochise County and the Tucson metropolitan areas served by TEP and Trico were conducted with the interaction of all potentially impacted stakeholders in an open, cooperative and interactive mode. Study assumptions in these cases were tailored to the needs of the specific area(s) under consideration.

Load Forecasts

All SATS participants with load serving responsibility within the study area provided "base" or "nominal" 20-Year peak demand forecasts including geographic allocation. In the figure below individual forecasts were summed, or "stacked" one on top of the other with TEP[1] at the bottom, SWTC added on, and so on. (Note that summing the individual forecasts does not take diversity into account.)

[1] Note that Unisource Energy loads in Santa Cruz County, that are currently supplied from the WESTERN system but are planned to be served from the TEP network at the Vail substation by 2012, are not included in the TEP forecast. The peak demand forecast for this area, and which was included in the models, ranges from approximately 90 MW in 2012 to about 125 MW in 2028.



SATS 20 Year Peak Demand Forecast

A general observation is that the load in the SATS area is expected to nearly double over the 20 year forecast period.

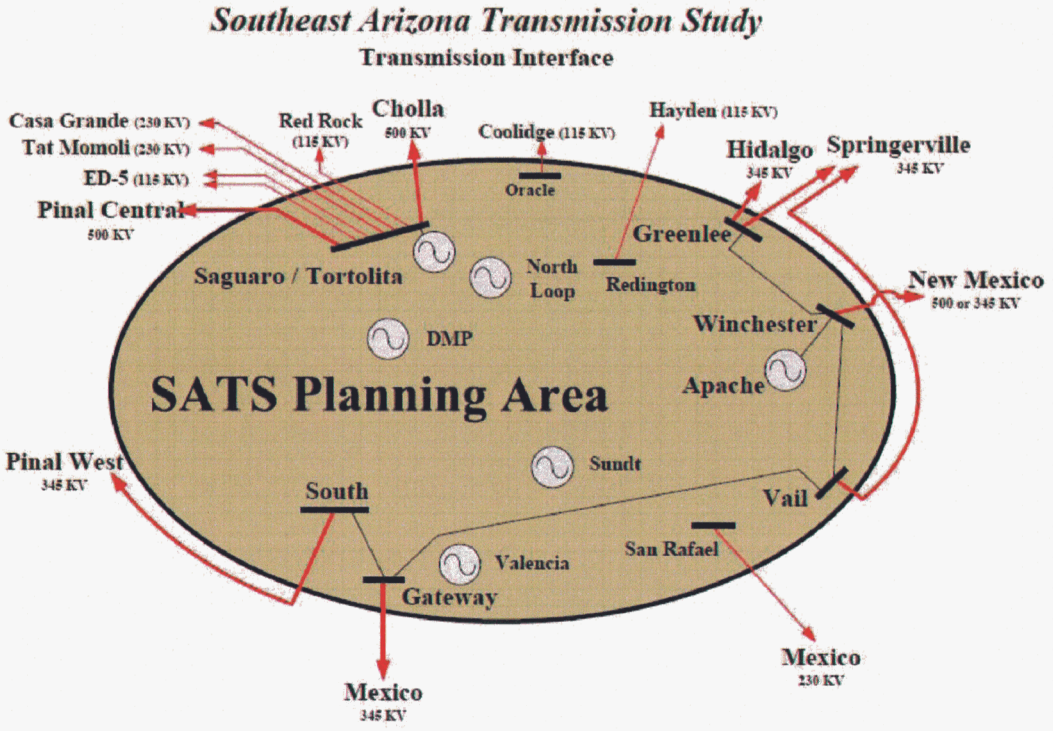
In addition to the 20 year forecasts illustrated above, TEP performed a "saturated" load study for their service area. General land use information obtained from local jurisdictions in the TEP service territory was used to develop geographically distributed peak demand data assuming ultimate build-out. This data was analyzed to identify likely locations for new distribution substations as well as expansion of existing stations. Alternative local area transmission lines were then evaluated to interconnect these new and expanded substations and integrate them into the existing local network. This exercise helped to identify potential future substation locations and transmission corridors needed to serve local loads.

Scenarios

Scenarios may be described as reasonably likely future states of the world (generally the Southwest in this case) that influence decisions about which projects or strategies should be pursued. Scenarios are typically characterized by critical uncertainties, such as the location and capacity of future generation and/or regional transmission projects and load forecasts. There is general recognition of the need to construct new EHV infrastructure to bring additional power from new resources into Arizona. Whichever

EHV project, or combination of projects is selected, there will be differing impacts on the local area systems in Southeast Arizona. For this reason multiple scenarios were developed and modeled. At this time, which of the possible Mega-Projects (TransWest Express, High Plains Express, SunZia, etc.) will be built is unknown. Hence they are treated as study uncertainties and represented as scenarios in the SATS study.

The SATS group agreed to develop a manageable number of materially different scenarios to aid in thinking about project creation and decisions. Scenarios representing major projects that may or may not be constructed are necessary to simulate projects that introduce new resources either directly into the SATS area or may otherwise be imported through potential EHV interconnection(s). As shown below, these scenarios were represented as equivalent generators located at the nodes where these projects are likely to interconnect, or where flows from the projects are likely to enter the SATS network.



SATS Scenario Import/Injection Locations

The generator locations and magnitude of power output used to model the scenarios, as

approved by the SWAT Steering Committee follow:

- Palo Verde (Hassaympa) Up to 1,000 MW
- Pinal West Up to 500+ MW
- Pinal Central Up to 500+ MW
- Winchester Up to 1,500+ MW
- Gateway/Aqua Prieta 500 MW to 1,000 MW

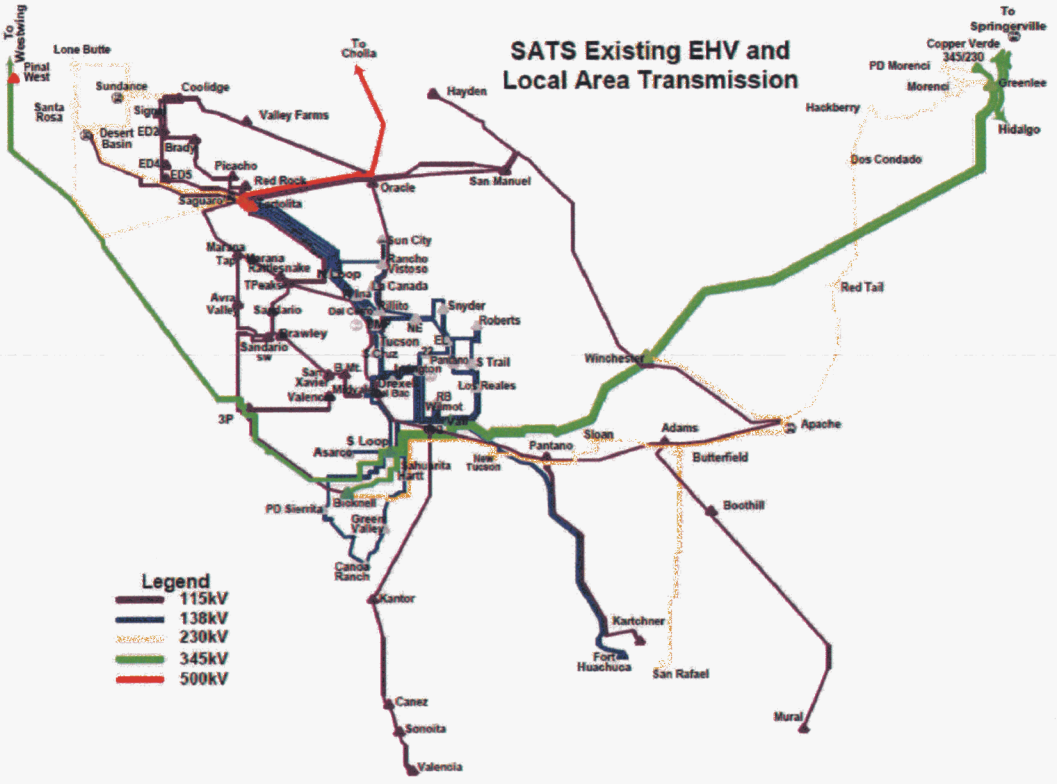
In the present round of studies all injections were assumed to be from Phoenix and southeastern Arizona. Sensitivity analysis to determine the impact of mega-projects south of Tucson will be accomplished as necessary in the next round of studies by turning on Gateway and/or Aqua Prieta and reducing the NW and SE scenario generation.

Current System

TEP's existing EHV transmission network, including jointly owned facilities, consists of about 512 miles of 500kV and 1,098 miles of 345kV transmission of which approximately 2 miles and 239 miles of 500kV and 345kV respectively are wholly owned by TEP. The balance of 510 miles of 500kV and 859 miles of 345kV are jointly owned.

SWTC's existing EHV transmission network, including jointly owned facilities, consists of 51.6 miles of 500 kV and 216 miles of 345 kV transmission of which approximately 2.46 miles and 46.08 miles of 500 kV and 345 kV respectively are wholly owned by SWTC. The balance of its transmission network consists of 537.6 miles of 230 kV, 115 kV, and 69 kV facilities .

The integrated APS, SWTC and WESTERN 115kV transmission facilities interconnect with the adjoining SWTC 230kV system. A significant portion of the 115kV system is networked with and is parallel to the 230kV lines. In addition, there are several radial lines serving loads in the southern and eastern portions of the SATS area.

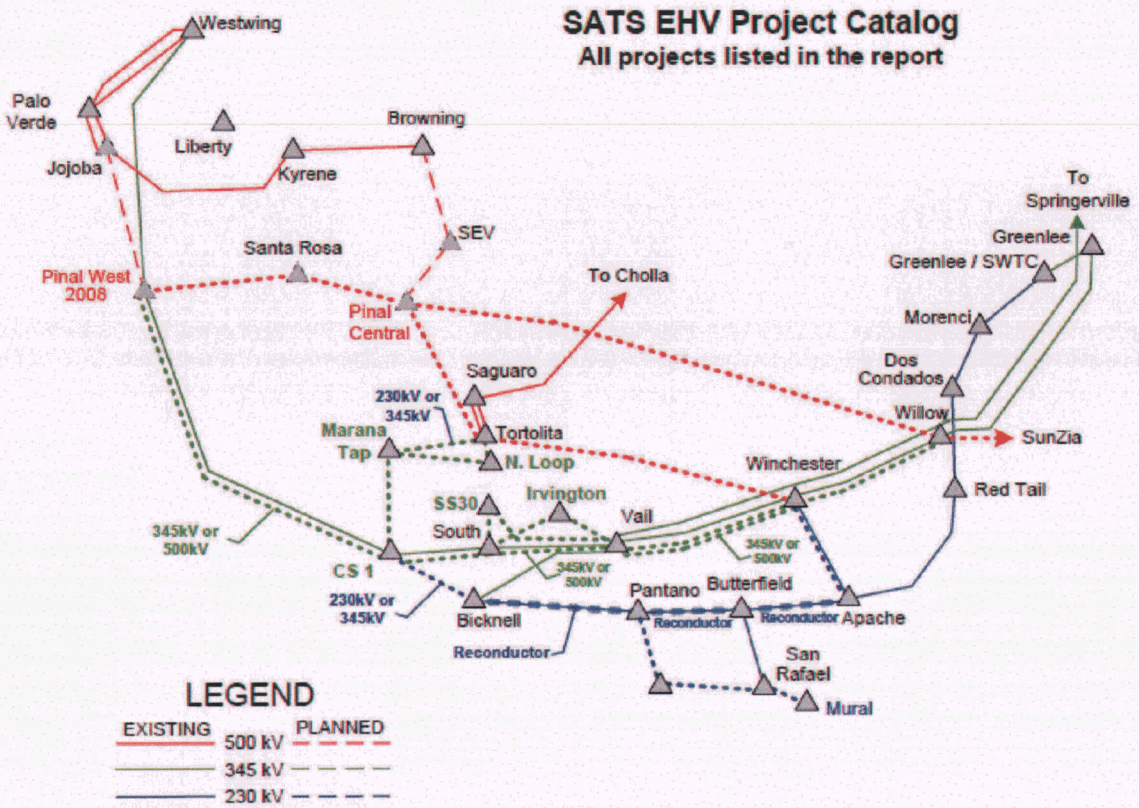


Within the SATS study area the Western 115kV transmission corridors have been identified as valuable assets for a number of the alternative projects. The value is associated with the location of the Western facilities and the potential to share capacity in upgrades to these facilities. As a component of the SATS study efforts Western was requested to review the status of its right-of-ways (ROW) from Saguaro and Oracle south through the Tucson area and east to Apache. The study results indicated that much of the Western Tucson area 115kV system could be upgraded as long as the new facilities resided within the existing 100 foot ROW.

Long-term Strategies

Long-term strategies were developed by assembling combinations of projects which were able to address the system issues identified in the power flow analysis. The approved SATS study scope calls for initial strategy designs to be based upon the assumption that future resource additions will come from either the northwest (PV HUB area) or southeast. Additional sensitivity analysis are planned to be subsequently performed assuming multiple sources of generation as well as internal generation. The

following map illustrates potential transmission expansion projects evaluated in the SATS studies.



Potential Transmission Expansion Projects

In addition to the SATS area wide strategies illustrated on the preceding map, local strategies were also developed for TEP and SWTC. Six EHV strategies were developed for the TEP system in the Tucson area, of which two were initially given high priority to be evaluated. However, what is identified in the report as "Strategy F" later emerged as the highest priority due to its favorable technical, economic and aesthetic characteristics. Strategy F includes two 345kV lines from Tortolita to North Loop and a new North Loop substation. It also includes a new 345 kV substation at Irvington with new 345kV connections from Irvington to Vail and South Loop. Modifications to the 138kV system design envision rebuilding or reconductoring existing multiple circuits between the EHV delivery points and the load centers within Tucson.

SWTC does not anticipate sponsoring any major EHV projects within the timeframe of this analysis. Therefore, its EHV strategies were dependent on other SATS participants EHV strategies. Since TEP was the only SATS participant with EHV strategies SWTC reviewed the TEP alternatives to evaluate which ones would be beneficial to the SWTC system.

Of the three areas that SWTC provides transmission service in this study, the Marana Area was the one that SWTC saw potential benefits from the TEP EHV strategies. There were possible joint projects identified such as 345kV facilities connecting Tortolita, Marana, Three Points and Bicknell. A 345kV line between North Loop and Tortolita has possible benefits to SWTC. These EHV strategies will need to be thoroughly evaluated both economically and technically.

In addition to the transmission plans of SWTC and TEP, the Southwest Public Power Resource (SPPR) group has proposed a project that interacts with potential SATS area projects in the northern portion of the study area. Therefore alternatives coordinating with the SPPR project should be investigated wherein new 230kV facilities extending into Tucson from the Marana Tap could interconnect with the local area 115kV and 138kV systems.

Findings from Power Flow Analysis

2010 Case Analysis – The 2010 cases assume that only those upgrades that are presently funded through approved capital improvement plans or other projects that are otherwise considered highly likely candidates to be funded and constructed by 2010, are in place.

For SWTC their 2009-2010 Construction Work Plan (CWP) includes upgrades of SWTC's existing system as well as joint projects between SWTC and others. Joint projects with CAP include the addition of two new substations, San Joaquin and Adonis, re-conductor of the existing Avra-Marana 115kV line and construction of a new 115kV line from Saguaro to Rattlesnake/Twin Peaks. Joint projects also include the SWTC and WESTERN construction of a new interconnection at the existing SWTC Pantano substation to the existing WESTERN 115kV line from Adams Tap to Nogales Tap.

TEP's upgrades consist of the addition of a new 500/345kV substation at Pinal West plus an SVC to provide voltage stability to the TEP 138kV network, both in 2008. During the process of preparing the five year capital budget, TEP determined that existing 138kV facilities between Tortolita and North Loop would limit load serving capability from the relatively strong source at Tortolita. Therefore significant upgrades were proposed in the Tortolita to North Loop corridor. They were recommended because of relatively high load growth and the need to increase transfer capacity from Tortolita. These upgrades consisted of a series of projects staged over the three year period 2008 to 2010.

2016 Case Analysis - Combinations of EHV and local area transmission projects that made sense based on the experience and judgment of TEP and SWTC transmission planners were added to the 2016 cases. This was to make reasonable efforts to identify which projects would be required for load serving capability based on information available at that time. This work was done prior to development and analysis of any saturation load level cases. Development of the 2016 case resulted in a nominal transmission configuration to establish a benchmark upon which to build a revised 10-year (2018) planning horizon case.

TEP upgrades consist of participating in the Pinal West to Pinal Central and SEV 500kV project and adding a new Pinal Central to Tortolita 500kV line plus additional 500/138kV transformation. Additional 345kV transmission will also be needed into Tucson to increase load serving capability. While a decision as to which EHV project had not been made, TEP initially modeled a new Tortolita to East Loop 345kV with a new 345/138kV substation at East Loop. Tortolita to East loop was modeled as it was included in the TEP Preliminary EHV Transmission Plan. In addition to these EHV projects a number of local 138kV projects were identified by TEP for the Tucson service area.

SWTC potential upgrades considered consisted of: (i) participation in the Pinal West to Pinal South 500kV project and the Pinal South to Tortolita 500kV project; (ii) interconnection of TEP's line from Pinal West to South 345kV line; (iii) a 230kV injection point into the SSVEC area; and (iv) upgrade of 115kV line from Bicknell to Three Points and Avra to Sandario to Three Points. Using the 2016 SATS base case, SWTC identified a number of potential upgrades as well as a number of possible interconnection points to evaluate in the 2011-2013 CWP process. Projects beyond the

2010 planning period remain conceptual and subject to change as future demands increase or decrease during evaluation.

2018 Case Analysis – The 2018 base cases evolved from the Saturation cases based on the assumption that loads were at 50% of estimated saturation levels. This observation was used to determine that portion of the substation and/or transformer capacity identified at saturation that would be required to serve load at the 50% point and subsequently the 10-year planning horizon, 2018. Only the EHV upgrades that were required to serve the load in 2018 were included. Initially two EHV options that yielded comparable Load Serving Capability were evaluated; the first being Tortolita to North Loop, and the second Tortolita to East Loop 345kV. Evaluation of these two options indicates that there are significantly greater impacts to the underlying 138kV system by terminating the EHV at North Loop than at East Loop. Though the East Loop EHV option requires less 138kV improvements it incurs the cost of the additional 23 miles of 345kV to extend beyond North Loop and terminate at East Loop.

Additional work is in process to model and analyze other alternative projects that are common to the most likely EHV strategies. The highest priority is Strategy F which envisions a new 345kV line from Vail to Irvington and continuing on to South Loop. This option also includes a new 345/138kV substation at Irvington. Two others, Strategy A and Strategy C will continue to be evaluated to determine their feasibility and cost effectiveness in order to preserving longer range planning flexibility. These particular projects have the potential to provide shorter-term load serving capability when and as needed, while retaining options which may be decided upon later to pursue any of the three strategies depending upon circumstances know at that time in the future.

2028 Case analysis - The results indicate that a fourth 500/138kV transformer will be needed at the Tortolita substation. Also the major components of the "reach-in" strategies should be in service at about the twenty year planning horizon. Reinforcement into the northwestern Tucson area, whether it be two 345kV lines to North Loop, as in Strategies C and F, or a variation involving 230kV as described in the 2018 case analysis above. Based on currently available information, TEP's preference would be for new 345kV lines from Vail to Irvington to South Loop with 345/138kV transformation at Irvington, or Strategy F. Otherwise Strategy C would be technically effective. Additional 345/138kV, 345 or 230/115kV and 345/230kV transformers will be

needed as well. More detailed analysis will be necessary to determine the number, size and timing for these various transformer additions.

At the 2028 load level, based on the 2008 load forecast, EHV reinforcement consisting of 345kV transmission additions into Vail from the east or into North Loop from the northwest would be adequate to serve SATS area load.

Saturation Case Analysis - Initial results indicated that the 345kV additions described in the 2028 case analysis would not be adequate to serve saturated loads. Therefore extensive 500kV additions were modeled, to include a second Pinal Central to Tortolita line, two Winchester to Vail lines and a Vail to South Loop to Pinal West line. Multiple 500/345kV transformers were required at the Winchester, Vail, South Loop and Pinal West substations. Note that the Tortolita to Winchester 500kV line was modeled in the 2028 cases, and remained in the saturated load cases. These extensive 500kV system upgrades technically meet the SATS area load serving needs. However no analysis was performed to optimize the system or to determine if other options might have extended the life of the 345kV upgrades modeled at the 2028 load level.

Cochise County Study

A sub-committee of the SATS group was formed to address the transmission and load serving concerns specific to the Cochise County area. Of particular concern to this sub-committee was the transmission system serving loads in and surrounding the City of Sierra Vista. Although these concerns have been raised in prior transmission planning activities, a series of outages experienced in the Sierra Vista area, during the period of October 9th through October 11th of 2007, emphasized the need to formalize the discussions and try to find an acceptable solution. When an ACC Staff member characterized the issue as; "one that is very serious and needs to be dealt with ASAP, SATS responded by creating the Cochise County Study Group. Leadership of the Group was assigned to Sulphur Springs Valley Electric Cooperative (SSVEC). SWTC agreed to perform the technical studies associated with the Group's efforts.

Transmission service in Cochise County consists principally of radial lines which feed into the underlying sub-transmission system. SWTC provides transmission service to SSVEC's Sierra Vista area loads principally via two radial lines; a 115kV line from Pantano to Kartchner substations and a 230kV line from Butterfield to San Rafael

substations. Some additional capacity can be imported into the Sierra Vista area over SSVEC's 69kV sub-transmission system from their tie to SWTC's Apache substation. WESTERN provides transmission service to APS which then delivers power, via a radial 115kV transmission line from the Adams Tap substation to its Mural substation, to serve its loads in the south-central and far southeastern corner of Cochise County. TEP serves Fort Huachuca via a radial 138kV line which emanates from its Vail substation. An alternative path for up to approximately 16 MW to Fort Huachuca is provided by a TEP 46kV sub-transmission line connected to the TEP 138kV bus at the South Loop substation. The issue presented for resolution to this subcommittee was that, under various load conditions, an outage of any one of these radial transmission lines (an N-1 condition) could result in the loss of load.

The subcommittee members held their meetings over the period of November, 2007 through January, 2008. The members of this subcommittee agreed that the objective of the study group would be:
To determine and recommend transmission solution(s) using 115, 138, and 230kV lines and substations to solve existing N-1 transmission problems within southern Cochise County.

During this period SWTC conducted a technical evaluation on seven transmission options proposed by the subcommittee. These seven options, which included upgrades to both the area's transmission and sub-transmission systems, were:

1. Pantano-Kartchner-San Rafael-Butterfield 230kV loop.
2. San Rafael to Mural 230kV Extension.
3. Sloan to Huachuca East Radial 230kV.
4. Tie of TEP's 138kV to SWTC's 115kV Lines.
5. Apache-Tombstone-Kartchner 115kV.
6. Emergency Tie to TEP's 138kV at Fort Huachuca.
7. San Rafael to North Kartchner 230/115/69kV.

The Cochise County Study Group agreed that an additional 230kV transmission line into the Sierra Vista area would be necessary to address system reliability and provide for expected future load growth. There was also agreement by the subcommittee that a 230kV loop through the Sierra Vista area is the preferred long-term technical solution.

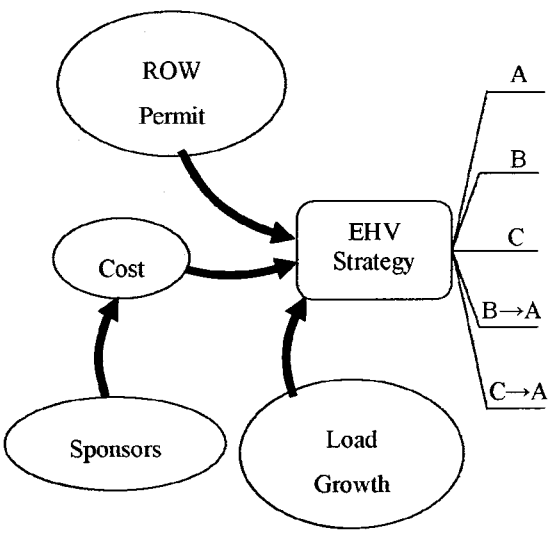
The future loop would not only eliminate reliability issues in the Sierra Vista area, but could also address future load serving issues for APS. What remained an issue within the subcommittee was the timing of this 230kV loop. However, no final conclusion, beyond the need for a 230kV loop, was reached in this initial phase of the Group's study process.

The recommendation of the Cochise County Study Group was to suspend its activities until the completion of a right-of-way study to be commissioned by SWTC. This study is intended to determine the probability of creating a new transmission corridor into the Sierra Vista area.

Developing a Flexible Plan

A flexible plan has built-in features that take uncertainty about future events into account. For example, a given strategy may ultimately offer the greatest load serving capability. However, it may also require the most new 345kV facility construction to implement at a relatively higher cost, and possibly also has the greatest risk associated with obtaining the permits to build. There may be further financial risk of potential stranded investment if projected load growth fails to materialize, or if the actual growth rate is significantly lower than currently forecasted.

Thinking about these uncertainties leads to the addition of variations to the basic strategies to attempt to mitigate regulatory and financial risks. For instance, Strategy B may be modified to preserve the option of switching to Strategy A by acquiring ROW or obtaining options on the rights-of-way needed to add the lines that would not otherwise be necessary in Strategy B. Modifications would also be considered for the Strategy B local area HV transmission plan, again to preserve the option to make the switch to Strategy A. This option is referred to as "B→A" in the below influence diagram.



Conclusions

There are significant benefits of a coordinated subregional study effort using a single system approach. The SATS participants directly involved in developing the study scope; in developing alternative strategies; in modeling and analysis; and documenting results gained a much better understanding of current and emerging system issues than would have been otherwise possible by working independently. Participants who diligently participated in the many meetings and teleconferences, and who reviewed the documentation provided excellent feedback, valuable information and insights that could not have been accessed otherwise.

Specific benefits of joint planning include the following:

- Provides a framework for SATS Transmission Providers to prepare capital budgets and ten year plans
- SATS provides a forum to ensure accuracy of planning models, and to identify system issues involving interconnected transmission facilities, and to jointly develop mutually beneficial solutions;
- Provides a protocol for establishing "need" during project siting activities before regulators;
- Potentially higher reliability, through the use of multiple corridors versus multi-circuits in single corridors wherever possible;
- Identification of potential joint projects which could result in lower overall

construction requirements;

- Working with adjacent subregional study groups provides an effective means to resolve seams issues;
- Lower individual technical and financial risk through better information and creative group thinking;
- Lower cost, aesthetic and environmental impacts through pursuit of possible joint projects.

Conducting a subregional study looking out beyond the ten year planning horizon creates a sound basis for developing short-term plans in the context of a long-term view. Key findings include:

- Identified key EHV strategies to serve saturated load at ultimate buildout;
- Identified potential future transmission corridors and substation sites;
- The plan recommends flexibility in view of uncertainty considering alternatives to minimize long term risk;
- Worked collaboratively with the Cochise County stakeholders in the pursuit of developing a short-term (3 to 5 year) plan to address existing contingency issues which will provide a long-term solution;

Establishing a subregional study group facilitates an on-going process to solve remaining or emerging issues:

- Five year planning horizon dilemma, described in Section 15, is to be addressed in the SATS 2009 study plan. The problem has been relatively well defined and divided into discrete geographical study areas within SATS;
- Ongoing effort will continue to guide and inform the public in stakeholder forums as well as Transmission Providers' capital budgets and ten year plans

Recommendations and 2009 SATS Study Plan

Recommendations for the SATS study are documented as a list of actions in the proposed 2009 SATS Study Plan as follows:

Proposed 2009 SATS Study Plan

- Present plan & subsequent findings to SWAT, WestConnect and to local stakeholders
- Revise load forecasts

- Engage SATS in early case building to ensure accuracy of database for 2009 ten year planning cases:
  - Focus on Arizona for ten year planning to include cases for years 1 through 5 plus year ten;
  - Preparation for ACC ten year plans, RMR, BTA and compliance studies;
  - Provide support and documentation to other regulatory agencies such as FERC and Rural Utility Services (RUS);
- Investigate implications of increased Freeport McMoRan Inc (FMI) loads in SATS study footprint:
  - Seek input from, and participation by FMI to address their anticipated plant expansion;
- Investigate alternative configurations to mitigate high flows on the Winchester 345/230kV transformer, Apache – Bicknell 230kV line and 230/345kV Bicknell transformer caused by EHV system contingencies;
- Develop and evaluate alternatives to the two joint Tortolita – North Loop 345kV proposal based on the SPPR Three Terminal proposal;
- Investigate impact of SunZia in coordination with CATS EHV, NM, SWAT RTTF study groups and other entities;
- Develop and evaluate alternatives for joint SWTC/TEP substation(s) to supply TEP/Trico loads south of Tucson;
- Continue Cochise County planning in an effort to comply with ACC Biennial Transmission Assessment recommendations;
- May conduct studies to accommodate renewable energy projects;
- Complete capital cost estimates and economic analysis, including losses;
- Identify potential projects;
- Conduct Scenario Sensitivity analysis, such as Load Forecast, Efficiency, Local Renewable Resources, Local & Distributed Generation, and location of external resources.

2. Introduction and Overview

Tucson Electric Power Company (TEP) and the Southwest Transmission Cooperative, Inc. (SWTC) initiated discussions in August of 2006 to pursue a joint transmission study. The first planning session, to identify common interests and to determine the feasibility of jointly pursuing a twenty-year transmission plan, was convened on August 31, 2006. The parties agreed that the potential benefits were significant enough to develop a

study work plan and to establish an open communication process to elicit broad participation by interested stakeholders.

The Western Area Power Administration (WESTERN) hosted a meeting on October 31, 2006 to explore opportunities presented by a joint planning effort. The timing coincided well with WESTERN's announced plans to conduct a study of the Southeast Study Region (SSR) of Arizona similar to the recently completed study of WESTERN's Northwest Study Region. Coordination of this study with the proposed joint Southeast Arizona Transmission Study made sense since the study area footprints coincide.

A work planning session was held at the Trico Electric Cooperative, Inc. (Trico) offices on December 5, 2006, by parties who were interested in a joint study. Participants included Arizona Public Service (APS), the Central Arizona Project (CAP), Public Service Company of New Mexico (PNM), Sulphur Springs Valley Electric Cooperative, Inc. (SSVEC), SWTC, Trico, TEP and WESTERN, plus other entities including the Entegra Power Group, LLC. (Entegra) and Southwestern Power Group (Bowie and SunZia Projects). These participants agreed that the study should be referred to as the Southeast Arizona Transmission Study (SATS) and further worked collaboratively in facilitated sessions on a draft work plan and schedule for the study. The results of this effort are documented in the SATS Work Plan and Schedule.

The formation of SATS was announced at the SWAT Oversight Committee meeting on October 18, 2006. SATS became a formal SWAT study group and a member of the SWAT Steering Committee. The SWAT Oversight Committee approved the study plan and schedule on May 16, 2007.

SATS participants jointly developed and agreed on goals and objectives, scope and schedule, methodology, criteria and resources to complete the study. A cornerstone of the process is that the study will be conducted on a "single system" basis. Detailed meeting and teleconference notes are available through the WestConnect website.

The SATS planning process has been open to any interested stakeholder with open communication and unencumbered information exchange encouraged and supported. The group has enjoyed the participation of project developers, load serving entities, customers, the Arizona Corporation Commission (ACC) staff, and others, along with

SATS area and neighboring transmission providers. The level of coordination that has taken place within SATS began before the implementation of FERC Order 890. All meeting notices of SATS are posted on the WestConnect website at www.westconnect.com and are forwarded to all entities within the WestConnect footprint via the SWAT e-mail blaster.

3. Participating Organizations

3.1. Acciona Energy: Acciona Energy, a Spanish company, develops and manages renewable energy projects, including small hydro, biomass, solar energy and thermal energy, and the marketing of biofuels. It also has assets in the field of co-generation and wind turbine manufacture. As of 2007, it is carrying out research projects to produce hydrogen from wind power and to manufacture more efficient photovoltaic cells. As of 2007, Acciona Energy is the largest developer, owner and operator of wind farms in the world, with 164 wind farms in nine countries representing over 4,500 megawatts (MW) of wind power installed or under construction. Acciona Energy is also the developer, owner and operator of Nevada Solar One, the world's first solar thermal plant built in more than 16 years, and the third largest facility of its kind.

3.2. Arizona Corporation Commission (ACC): The ACC is a regulating agency for the public power corporations created under the state of Arizona Constitution. Under a state statute, ACC conducts a biennial transmission assessment for the state of Arizona. The ACC has also the authority to approve siting of transmission lines, 115kV and above, and power plants 100 MW and larger. The Commission Staff participates in the regional and sub-regional transmission planning forums.

3.3. Arizona Independent Scheduling Administrator Association (AzISA): AzISA is a voluntary, non-profit Arizona corporation formed January 1, 1999, as an interim electric transmission scheduling administrator to facilitate the operation of Arizona's competitive electric retail market until a regional independent system operator, becomes operational. AzISA will initially administer and oversee all activities on the OASIS of the control area operators.

AzISA intends to serve as the scheduling administrator on behalf of the providers and users of the interconnected transmission system within the State of Arizona and to facilitate open, non-discriminatory transmission access on the interconnected transmission system. If there is distribution congestion, then there may be a role for AzISA in overseeing distribution congestion management and distribution access.

3.4. Arizona Power Authority (Authority): The Authority is a body corporate and politic established by the Arizona legislature in 1944. The Authority is directed to obtain electric power developed from the administration of the Colorado River and sell such capacity and energy to certain qualified purchasers in the State of Arizona. The Authority's primary source of power is the Hoover Plant at Hoover Dam located approximately 25 miles from Las Vegas, Nevada. Transmission of Hoover River power to Arizona is made available primarily through purchases of transmission capacity from WESTERN.

The Authority's participation in SATS is to ensure reliable transmission service to its wholesale contractors within or near the SATS footprint.

3.5. Arizona Public Service (APS): APS provides electric service to several Cochise County load pockets. In a continuing effort to provide reliable and cost effective service, APS coordinates development of the load serving network with all regional, and local load serving entities. SATS, being a subcommittee of the regional SWAT coordination group, is undergoing a long term electric reliability assessment of the future Cochise county load serving capacity. APS participation within the SATS assessment is to ensure that all future electrical network additions are coordinated with planned future facility additions of the other SATS members.

3.6. Central Arizona Project (CAP): CAP is a water resource development and management project that delivers Colorado River water, either directly or by exchange, into central and southern Arizona. The project was designed to provide water to nearly one million acres of Indian and non-Indian irrigated agricultural land areas in Maricopa, Pinal and Pima Counties, as well as municipal water for several Arizona communities, including the metropolitan

areas of Phoenix and Tucson. The United States Bureau of Reclamation ("Reclamation") constructed and owns the features of the CAP. Under contract with Reclamation, CAWCD operates and maintains the CAP and repays the Arizona portion of the United States' construction costs. The balance of the costs was to settle Indian water rights claims.

The CAP features include nearly 400 miles of 230kV, 115kV and 69kV transmission lines and substations to serve the pumping loads that deliver the water to the state users. The CAP also has generation and transmission rights in the Navajo and Inter-tie Projects as well as Hoover Dam. There are 31 miles of 115kV transmission line within the SATS study area to the west of the Tucson Mountains and 38 miles of 115kV transmission lines originating at Electric District #2 substation and connecting to Saguaro generating station switchyard, which is at the northern boundary of the SATS study area. These two transmission lines serve nine of the 15 CAP pumping plants across the state. CAP is the largest single user of electricity in the state and has a combined load of nearly 500 MW.

3.7. El Paso Electric (EPE): EPE is an interconnected member of the Western Electricity Coordinating Council (WECC) and is located at the far southeastern corner of WECC. EPE is connected to the Southwest Power Pool (SPP) only through an asynchronous tie. In total, EPE owns, in whole or in part, approximately 950 miles of 345kV transmission line, most of which is located within New Mexico. EPE's Extra High Voltage (EHV) transmission system is comprised of three chief components: a series of 345kV AC lines that connect EPE's local transmission system in and around the City of El Paso to the WECC interconnected grid; the single 345kV line that interconnects EPE's local transmission system to the SPP through an HVDC terminal; and the 345kV transmission lines that distribute power imported from the WECC and SPP to EPE's local system. EPE's major transmission interconnections with other utilities are at the (1) West Mesa Switching Station near Albuquerque, New Mexico with Public Service Company of New Mexico (PNM); (2) Eddy County HVDC Terminal near Artesia, New Mexico with Southwestern Public Service Company (SPS); and (3) Springerville Generating Station and Greenlee Substation (both in Arizona) with Tucson Electric Power Company (TEP). EPE

also has a partial ownership interest in three 500kV transmission lines in Arizona, from the Palo Verde Nuclear Generating Station's switchyard to the Kyrene and Westwing Substations in the Phoenix area. EPE has approximately 800 MW of wholly-owned gas-fired generation in the EPE service area and is a joint owner in the coal-fired Four Corners Power Plant (104 MW) and Palo Verde Nuclear Generating Station.

3.8. Environmental Planning Group (EPG): EPG is an interdisciplinary environmental planning and design firm that places responsibility, integrity, and the balance of human, natural, and cultural resources at the forefront of project development and resource management.

3.9. Fort Huachuca: Fort Huachuca is a major Army installation located in Western Cochise County. This facility is equivalent to a city of 15,000 and is one of the largest employers in Southern Arizona. One of the prime missions, electronic testing was located here due to the low electric and magnetic fields (EMF). High Voltage Electric Transmission lines create EMF. The Fort's interest in participating in coordinated transmission planning with local and SATS area transmission providers and other stakeholders is for Energy Security (reliability) and encroachment on mission (increased EMF).

3.10. New Mexico Regional Transmission Authority (RETA): RETA was created to expand renewable energy transmission and storage projects. The projects undertaken by RETA must source at least 30 percent of their energy from renewable energy sources. RETA is a stand-alone entity administered by an eight-member board. Five members are appointed and serve staggered three-year terms and three are government representatives. RETA can identify and establish corridors for transmission of electricity within the state; participate in regional transmission forums to plan and negotiate for the creation of interstate transmission corridors; finance or plan, acquire, maintain and operate eligible facilities; and exercise the power of eminent domain to forward the development of its projects as long as utility property is not taken and electric reliability is not materially diminished, as determined by the New Mexico Public Regulation Commission.

3.11. Public Service Company of New Mexico (PNM): PNM is New Mexico's largest electricity and natural gas provider, is based in Albuquerque and has offices in more than 20 cities. PNM serves about 487,000 electricity customers and about 490,000 natural gas customers in about 100 communities statewide and also sells electricity on the wholesale market.

3.12. Southwest Area Transmission (SWAT): SWAT is comprised of transmission regulators/governmental entities, transmission users, transmission owners, transmission operators and environmental entities. The goal of SWAT is to promote regional planning in the Desert Southwest. The SWAT regional planning group includes several subcommittees, which are overseen by the SWAT Oversight Committee.

3.13. Southwest Transmission Cooperative (SWTC): SWTC owns and operates transmission facilities and has rights to transmission service to support its six member distribution cooperatives located in the Arizona, Southern California, and New Mexico region. The six cooperatives are Anza Electric Cooperative (AEC), Duncan Valley Electric Cooperative (DVEC), Graham County Electric Cooperative (GCEC), Mohave Electric Cooperative (MEC), Sulphur Springs Valley Electric Cooperative (SSVEC) and Trico Electric Cooperative (Trico). Currently SWTC maintains 608 miles of transmission lines ranging from 69 to 345kV.

SWTC has a vested interest in participating in SATS because four member cooperatives reside in southeastern Arizona. These cooperatives include DVEC, GCEC, SSVEC and Trico. SWTC has seen much benefit in conducting long range studies to identifying joint projects and critical upgrades to the existing system that will allow SWTC to serve projected load growth with the interconnected power system of participating utilities.

3.14. Southwestern Power Group (SWPG): SWPG is an energy project development company located in Phoenix, AZ. SWPG provides front-end project development services for large power generation and EHV transmission projects, including site acquisition, state and county licensing and permitting, federal licensing and permitting, WECC approvals and other pre-construction

activity. SWPG is the owner-developer of Bowie Power Station and SunZia Southwest Transmission Project.

3.15. Sulphur Springs Valley Electric Cooperative (SSVEC): SSVEC is a non-profit, member-owned distribution cooperative providing electricity to more than 50,000 services over some 4,000 miles of energized line. Located in southeastern Arizona, the cooperative's service territory covers parts of Cochise, Graham, Pima and Santa Cruz Counties and includes the communities of Sierra Vista, Huachuca City, Patagonia, Elfrida, Benson, St. David, Bowie, San Simon, Willcox, Sonoita and Pearce-Sunsites.

3.16. SunZia Southwest Transmission Project (SunZia): SunZia is evaluating the potential to develop a new regional electric transmission line between southern New Mexico and southern Arizona. SunZia would allow potential future development of power from renewable energy sources, such as geothermal, wind, and solar, to be transported by the SunZia Project to the Arizona and New Mexico regional transmission systems. SunZia is a participation transmission project that is being developed by Southwestern Power Group of Phoenix, AZ.

3.17. Trico Electric Cooperative, Inc. (Trico): Trico, a Touchstone Energy® Cooperative, is a member-owned, non-profit electric distribution cooperative headquartered in Marana, Arizona, northwest of Tucson. Established in 1945, Trico provides electric service to more than 35,000 member customers over nearly 3,200 miles of line. Trico serves a diverse membership, including urban, suburban and rural communities in northwest Tucson, Green Valley, Marana, Sahuarita, Corona de Tucson and Arivaca

3.18. Tucson Electric Power Company, Inc. (TEP): TEP, a UniSource Energy subsidiary, is a vertically-integrated electric utility that provides retail electric service to more than 375,000 customers in Southeastern Arizona. Tucson's service territory consists of a 1,155 square mile area and includes a population of approximately 931,000 in the greater Tucson metropolitan area of Arizona. UniSource Energy Services (UES), another UniSource Energy subsidiary within the SATS geographic area, is a utility that provides electric service to customers in Santa Cruz County.

3.19. Western Area Power Administration (WESTERN): WESTERN markets and delivers reliable, cost-based hydroelectric power and related services within a 15-state region of the central and western U.S. WESTERN is one of four power marketing administrations within the U.S. Department of Energy whose role is to market and transmit electricity from multi-use water projects. WESTERN's transmission system carries electricity from 57 power plants operated by the Bureau of Reclamation, U.S. Army Corps of Engineers and the International Boundary and Water Commission. Together, these plants have an installed capacity of 10,395 megawatts.

WESTERN and its energy-producing partners are separately managed and financed. In addition, each water project maintains a separate financial system and records.

3.20. Western States Energy Solutions, LLC: Western States Energy Solutions is a consulting company with expertise in transmission planning, interconnections, and transmission service. It also consults on interconnection configuration, operations issues, relaying configurations, and power related communications issues. Clients include renewable energy developments in New Mexico, Tribal renewable projects in New Mexico, Arizona and California, and gas fired generation in Mexico. Western States Energy Solutions LLC interest in SATS is the development of transmission that will also include wheeling for renewable energy resources to the Tucson and Phoenix areas for New Mexico wind and solar energy projects.

4. Definitions

4.1. Delta V: Change in voltage between pre- and post-contingency conditions.

4.2. Extra High Voltage (EHV) is the term applied to voltage levels that are greater than 230kV.

4.3. High Voltage (HV) is the term applied to voltage levels greater than 100kV and less than or equal to 230kV.

4.4. Initially Out of Service (IOS): A system element is IOS if it is out of service and system adjustment is complete.

4.5. Load Serving Capability (LSC): LSC is the greatest amount of load that can be

served considering EHV and HV system limitations, through the combination of transmission capability and maximum available local generation within any given load pocket, while meeting NERC/WECC/Local Internal Reliability Criteria.

4.6. Load Serving Entities: The entity that secures energy and transmission service (and related Interconnected Operations Services) to serve the electrical demand and energy requirements of its end-use customers.

4.7. North American Electric Reliability Corporation (NERC): NERC is an international, independent, self-regulatory, not-for-profit organization, whose mission is to ensure the reliability of the bulk power system in North America.[2]

4.8. Special Protection Scheme (SPS) or Remedial Action Scheme (RAS): SPS or RAS is designed to detect abnormal system conditions and take pre-planned, corrective action (other than the isolation of faulted elements) to provide acceptable system performance. SPS actions include among others, changes in demand (e.g., controlled load shed), generation, or system configuration to maintain system stability, acceptable voltages, or acceptable facility loadings.

4.9. Static VAR Compensator (SVC): An SVC is an electrical device capable of continuously providing reactive power to control dynamic voltage swings under various system conditions.

4.10. System Adjusted: System Adjusted is the post-contingency condition after local generation is adjusted as needed, reactive devices are switched as needed, and elements / load out of service are restored as possible.

4.11. Transmission Providers: A Transmission Provider is "Any public utility that owns, operates or controls facilities used for the transmission of electric energy in interstate commerce".[3]

4.12. UniSource Energy Corporation: Unisource Energy Corporation (NYSE: UNS) is the largest publically-traded company headquartered in Tucson, Ariz. UniSource Energy's primary subsidiaries include Tucson Electric Power (TEP), which serves nearly 400,000 customers in southern Arizona; and UniSource Energy Services (UES), a utility that delivers natural gas and electric service to more than 240,000 customers across Arizona.

4.13. WestConnect: WestConnect is composed of utility companies providing

[2] Source: NERC website.
[3] Source: 18 CFR Part 358 [Docket No. RM07-1-000; Order No. 717], Standards of Conduct for Transmission Providers, (Issued October 16, 2008)

transmission of electricity in the southwestern United States. The members work collaboratively to assess stakeholder and market needs and to develop cost-effective enhancements to the western wholesale electricity market. WestConnect is committed to coordinating its work with other regional industry efforts to achieve as much consistency as possible in the Western Interconnection[4].

4.14. Western Interconnection: The Western Interconnection is one of the two major alternating current (AC) power grids in North America. The other major interconnection is the Eastern Interconnection. The three minor interconnections are the Québec Interconnection, the Texas Interconnection, and the Alaska Interconnection[5].

All of the electric utilities in the Western Interconnection are electrically tied together during normal system conditions and operate at a synchronized frequency operating at an average of 60Hz. The Western Interconnection stretches from Western Canada South to Baja California in Mexico, reaching eastward over the Rockies to the Great Plains.

4.15. Western Electricity Coordinating Council (WECC): The Western Electricity Coordinating Council is a Utah nonprofit corporation with the mission to: 1) maintain a reliable electric power system in the Western Interconnection that supports efficient competitive power markets; and 2) assure open and non-discriminatory transmission access among Members and provide a forum for resolving transmission access disputes between Members consistent with FERC policies where alternatives forums are unavailable or where the Members agree to resolve a disute using the mechanism provided in Section 11 (Transmission Access Mission).

5. Study Process

The SATS study process is consistent with SWAT, WestConnect and Western Interconnection regional planning processes. Since SATS was formed the entire study process has been a collaborative effort that was conducted in an open and transparent stakeholder forum. SATS is recognized as a sub-regional study group within SWAT,

[4] Source: WestConnect website.
[5] Source: WECC website.

and has engaged stakeholders through a transparent process well before this process became a requirement through the FERC Order 890. This process is documented in SATS participating transmission providers' Attachment K to their respective Open Access Transmission Tariffs (OATTs).

SATS has chosen to conduct the study in light of both local and regional needs and concerns. Southeast Arizona is a rapidly growing area with a pressing need to increase local area Load Serving Capability (LSC). The base assumption is that all incremental loads, with the exception of the output from the existing four Sundt steam units and the DMP combustion turbine in the TEP system as described in Section 13, will be supplied from remote resources. Transmission plans resulting from the assumption that all incremental loads will be supplied by remote resources will logically indicate the largest transmission infrastructure capital improvement requirements. This plan may then serve as the benchmark against which to measure deferral or elimination of potential transmission upgrades associated with options to increase energy efficiency, distributed generation, new local generation and other measures. Hence, opportunities to maximize the regional value of transmission investment to import remote resources are welcome, and will be explored as they become known. In addition, the group recognizes the importance of actively evaluating impacts of potential EHV transmission and remote resource projects that are under consideration to transmit large quantities of power to and through SATS. These projects are significant due to SATS' strategic location bordering Mexico, New Mexico and the high growth power markets north and west of the greater Tucson area.

Renewable resources are implicitly considered as they are anticipated to become a larger portion of the remote resources under consideration to be transmitted into the SATS load pocket. The SATS group relies on information related to evolving efforts to transmit renewable energy into and through Southeast Arizona. For example, RETA, along with other SATS participants, will be working with the AZ/NM Renewable Task Force that was set up under SWAT to define renewable energy areas in the state of New Mexico. At the same time RETA plans to be actively involved in the Western Renewable Energy Zones (WREZ) designations. RETA has taken the PNM transmission map along with the wind, solar and geothermal NREL maps, including what is in the queues for renewable resources in New Mexico and has identified locations on a map along with the estimated potential amount. Upon public comment of

the renewable areas, RETA will be looking to define a transmission corridor to export the renewables.

Large projects intended to import new resources, including renewables, are modeled as described in Section 12: Scenarios. Therefore the SATS "reliability" study will provide a sound foundation for the "economic" study process conducted by the Transmission Expansion Planning Policy Committee (TEPPC) of the Western Electricity Coordinating Counsel (WECC). The AZ/NM Renewable Task Force has evolved to become the SWAT Renewable Transmission Task Force (SWAT RTTF) and is expanding its scope to include most of the WestConnect footprint. RETA, TEP and other SATS members are active participants in the expanded SWAT RTTF and in the TEPPC Technical Advisory Subcommittee (TAS). These regional groups are focused on identifying and characterizing significant wind, solar, geothermal and biomass renewable energy resources that are located throughout the Western Interconnection. The general objective of TEPPC is to provide a database, model and preliminary analysis that may be utilized to help facilitate development of renewable projects in conjunction with additional transmission capacity needed to transmit generation projects' output to load centers throughout the west. These regional efforts are intended to dramatically increase the likelihood that mega-projects such as those represented in Section 12: Scenarios will be built.

The SATS study process does not make any provisions for renewable resource integration nor for regulation service that may be necessary to accommodate intermittent or non-dispatchable renewable resources injecting into the SATS Planning Area.

SATS engaged the SWAT Steering Committee, consisting of the sub-regional study group Chairs, to formulate scenarios that simulate large proposed generation and/or associated EHV transmission projects. These potential projects, until commitments are made to pursue any of them, are uncertain and therefore treated as scenarios. In order to expedite twenty-year planning, the SATS participants agreed to scale loads and necessary transmission reinforcement alternatives within the SATS area while maintaining external systems load and resource balance based on the SWAT 2016 base case available at the beginning of the SATS process.

During this process a problem was identified in that a significant increase in SATS load causes thermal stress on surrounding systems external to the SATS footprint. Scenarios were developed to alleviate this problem by simulating possible large generation and transmission projects. This effectively provided an external system equivalent in the absence of a SWAT or other system-wide base case modeling expansion plans beyond the ten-year planning horizon. These scenario proposals were represented as equivalent generators located at the nodes where these projects are likely to interconnect, or where flows from the projects are likely to enter the SATS network. More detail on scenarios is presented in Section 12: Scenarios.

6. Study Goals and Objectives

The goal is to have a 20 year transmission plan covering the entire SATS area assuming transmission and distribution facilities are owned and operated as a "single system". Note that SATS participants may have transmission assets outside of the SATS study boundary, and therefore not included in the scope of the SATS study. Key objectives include:

6.1. A transmission plan that provides Load Serving Capability, attempting to minimize investment, to serve SATS area customer needs supplied from remote resources. Adequate capability is measured by meeting applicable North American Electric Reliability Corporation (NERC), WECC and local reliability standards and criteria.

6.2. A transmission plan consisting of alternative projects that offer mutual benefits, and therefore an opportunity to minimize cost through joint ownership. Joint projects can minimize aesthetic and environmental impacts by avoiding construction of redundant facilities. Projects are to be divided into categories to indicate which are planned for the near term (e.g. five year planning horizon) and most likely to be implemented versus a "catalog of projects" that are under consideration among others and potentially competing for selection beyond the five year planning horizon.

6.3. An inherently flexible transmission plan that responds to future uncertainties such as load forecast error, ability to site new transmission projects, decisions and timing for large generation and/or transmission projects, plus related

technical or financial risk.

6.4. A sound basis for developing individual Transmission Provider long-range transmission plans. A key objective is to develop and compare joint SATS strategies against plans that individual Transmission Providers might otherwise prepare independently.

6.5. A transmission planning document and process that facilitates ongoing assessment of future opportunities to further optimize long-range strategies. Future opportunities, including those that may defer or eliminate transmission investment include local or regional renewable resources; demand side technologies; clean and efficient advanced distributed energy conversion technologies; potential load management and remedial action schemes (RAS); and others.

TEP and SWTC are preparing individual twenty year transmission plans which will be informed by this SATS planning effort. Each recognizes that the contiguous nature of their service territories and interconnected transmission facilities must be considered in their respective long-range transmission plans. Each is interested in identifying projects that offer mutual benefits and therefore may be candidates for potential joint projects.

APS, CAP and WESTERN own and operate 115kV transmission facilities in the SATS area. They are preparing long range transmission plans recognizing that interconnected facilities present similar opportunities for integration into joint projects that may provide mutual benefits.

7. Study Scope and Schedule

The SATS study area encompasses the southeastern portion of Pinal, southern Graham, most of Pima and all of Cochise and Santa Cruz Counties. There are transmission and generation facilities owned and operated by various entities including Arizona Electric Power Cooperative (AEPCO), WESTERN, CAP, and APS in addition to SWTC, TEP and UNS Electric in the SATS study area. There are also possible generation and transmission project proponents within the area, such as the Bowie Power Station generation project and the SunZia Southwest Transmission Project, who participate in SATS. Other stakeholders included the Arizona Corporation Commission

(ACC), Fort Huachuca, vendors and consultants.

Figure 1: SATS Study Footprint shows the geographic area and transmission systems to be included in the study.

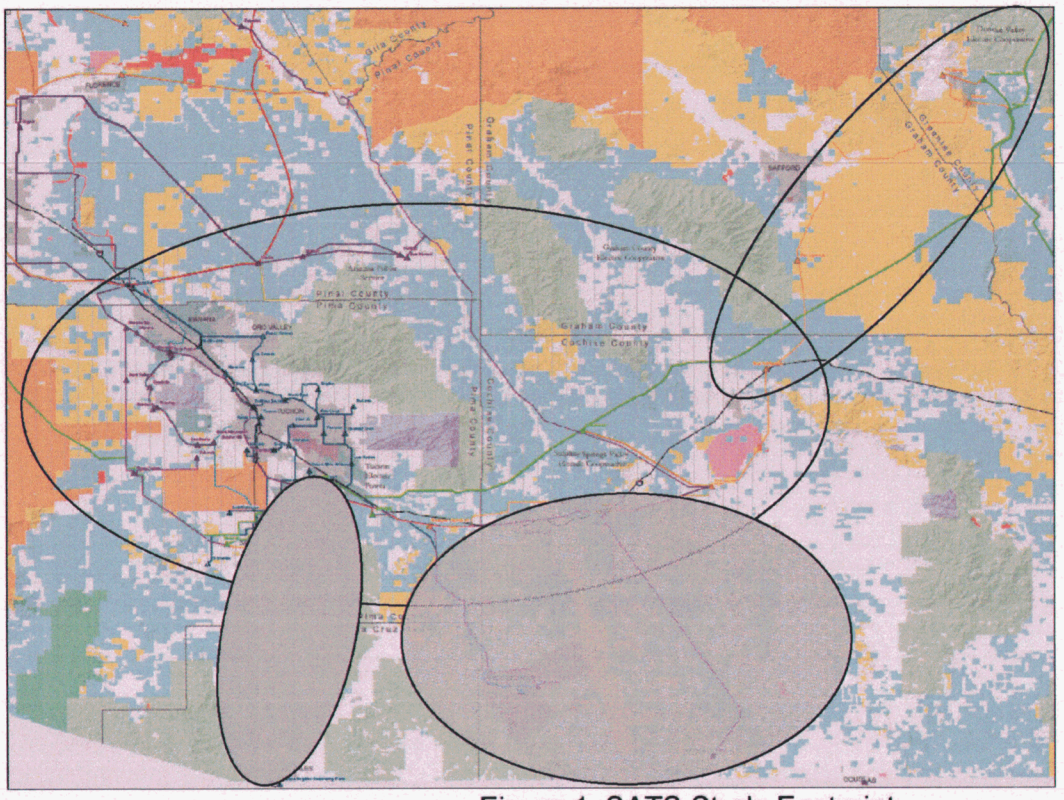


Figure 1. SATS Study Footprint

Note that the SATS footprint encompasses a broad range of land uses, jurisdictions and system challenges. For example, the Tucson and surrounding metropolitan area is undergoing rapid growth and development, and becoming a higher density urban environment. The communities south of Tucson and in Cochise County are also experiencing development pressures but do not have the extensive existing infrastructure normally associated with more highly populated regions. Therefore SATS must view its understanding of issues and potential solutions from these differing perspectives. Sub-studies were undertaken to address these special circumstances, and are addressed in other sections of this report.

The initial schedule for the study is shown in Figure 2: Original SATS Schedule below:

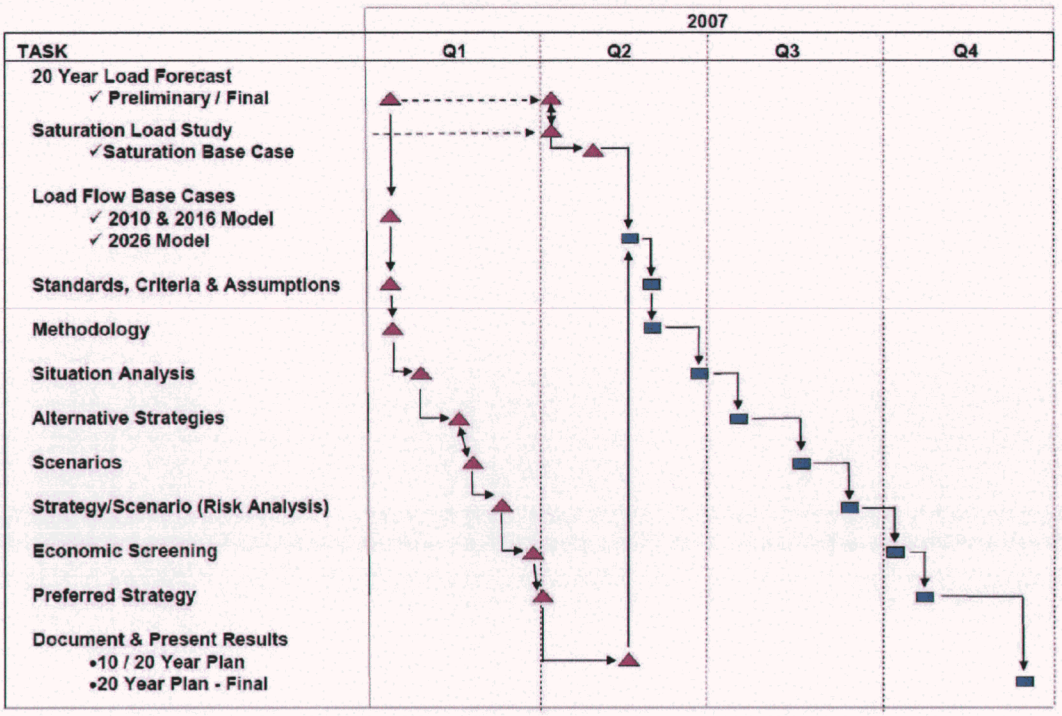


Figure 2. Original SATS Schedule

The actual sequence and timing of activities has not been precisely followed. Revisions to the scope such as addition of cases for 2018 and changing from 2026 to 2028 for the twenty year planning horizon came about as a result of lessons learned while conducting the saturation study. The saturated load study (described in Section 10), particularly power flow case and alternative strategy development also took significantly longer than expected. Most of the work based on the original 2016 case was redone to take the addition of as many as 40 potential new load serving substations and associated 138kV infrastructure for the TEP system into account. A summary showing the number of existing and potential new substations is included in Section 9.7 Table 5. TEP Load Serving Substations. Significant progress was made in 2007 with a great deal accomplished in 2008 as outlined in the SATS 2008 Transmission Study Plan. The revised schedule is shown in the following Figure 3. 2008 SATS Schedule.

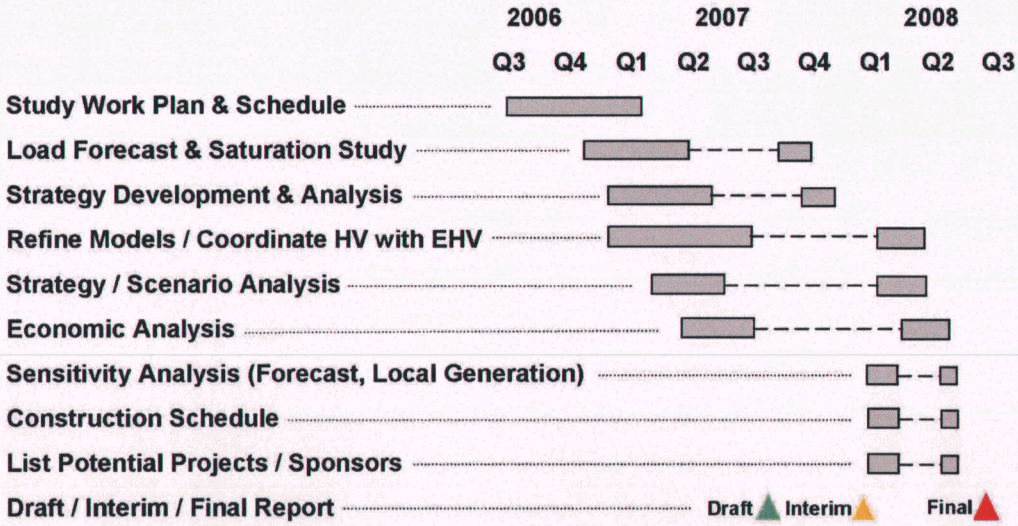


Figure 3. 2008 SATS Schedule

The first three tasks, Study Work Plan & Schedule, Load Forecast & Saturation Study and Strategy Development & Analysis, were essentially completed by the end of 2007. The next three tasks continued well into 2008. The power flow models were refined to incorporate transmission system topology changes that were identified during the Saturation Study and Strategy Development & Analysis phases. The revised models were such a significant improvement that all SATS participants agreed to extend the original schedule. This allowed the study to proceed based on much more sound information.

Economic Analysis consisted of alternative projects capital cost estimates that were prepared individually by the SATS Transmission Providers. However, the Transmission Providers decided to not disclose these preliminary estimates due to sensitivity over uncertainty associated with land and environmental costs as well as concerns that this information might influence actual land costs. Therefore the SATS 2009 Study Plan will include tasks to work with other subregional and regional planning entities in the Western Interconnection to arrive at cost estimates that are consistent throughout the west.

Limited sensitivity analysis was done to gain an understanding of the potential for deferring or eliminating transmission investment by changes in the demand for

electricity and/or the addition of generation within local load pockets. These initial findings suggest that more in-depth analysis should be pursued in 2009.

Lists of Potential Projects & Sponsors and their associated Construction Schedules were developed and included in this report. The list includes projects that are the most likely candidates to be incorporated into the individual SATS participating Transmission Providers' ten year transmission plans. A "catalog of projects" listing other alternatives that did not appear to be as likely to be developed was also prepared. The "catalog" is important to retain as some of these projects could become more viable candidates due to changing future circumstances. Thus the SATS study provides valuable information to help guide development of coordinated capital budgets and long range transmission plans of the individual Transmission Providers. This includes having a better understanding of projects that may be jointly pursued.

The SATS study report, which initially served as a guide for the study and documentation of the process, has evolved into this report.

7.1. The electrical interface between SATS and external systems was defined to provide as much clarity as possible about which transmission systems are included. This interface identifies the boundary between the long-range SATS planning model, and the external systems which are modeled only ten years into the future. The SATS interface is illustrated in Figure 4: SATS Transmission Interface below:

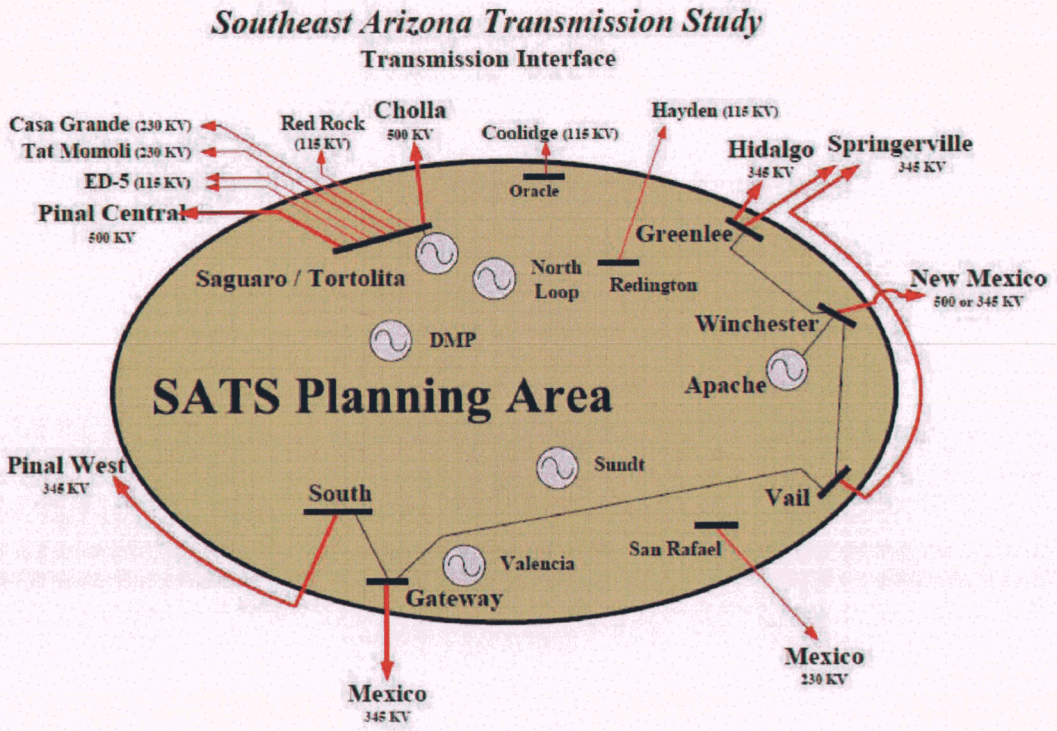


Figure 4. SATS Transmission Interface

Note that this diagram is intended to illustrate key transmission and/or generation interconnections only. It is not intended to serve as an accurate transmission system single line diagram. Hence no transformation among voltage levels is represented.

7.2. The planning horizon for this study covers the twenty year time frame from 2007 to 2028. However, the saturation study, in addition to geographically distributed loads, provided insights beyond the twenty year planning horizon. The primary purpose of the saturation study was to ensure that projects proposed for the twenty year planning horizon would continue to be technically and economically viable. Similarly project viability in the twenty year time frame helps to identify and prioritize which projects to include in the catalog. More detailed information is included in Section 10: Saturated Load Study.

7.3. Aggregate twenty year load forecasts were provided by the SATS load serving entities. These forecasts primarily serve as a guide for determining when SATS

area transmission additions would be required, and to determine the magnitude of incremental remote resources.

7.4. Development of power flow bases cases for 2010, 2016, 2026 and Saturation was proposed. The purpose of 2010 was to assess projects for the three-to-five year time frame to determine which, if any, issues required resolution using short-term measures. 2016 was chosen based on availability of a SWAT case to develop a ten year case. Scope changes were made as the study effort progressed and preliminary Saturation case results became available. A twenty year base case (2028) was prepared from the Saturation case by scaling loads down to approximately 75%, and additional ten year (2018) analysis was based on a greater than 50% Saturation case. Thereafter cases were developed to characterize the system at the approximate five year planning horizon and to test alternative projects. TEP utilized this information to prepare cases and to conduct analysis for the preliminary 2009-2013 capital budget. Note that percentages referenced to Saturation apply only to TEP.

7.5. Need for transmission line or substation projects is generally based upon a determination that existing facilities are not adequate to provide reliable services to customers at the lowest possible cost with due consideration to minimizing environmental and aesthetic impacts. SATS participants apply NERC and WECC Planning Standards, and individual utility specific criteria to analyses to make this determination. Transmission planning personnel endeavor to recommend projects that meet these standards and criteria, and those which make economic sense in the context of long-term transmission planning strategies. Long-term transmission planning covers a planning horizon of twenty years with consideration of ultimate build out scenarios that extend well beyond the twenty year horizon. In turn, having a catalog of alternative EHV and local area transmission projects for the twenty year planning horizon provides better information, influencing decisions about which projects to pursue in the ten year planning horizon. Hence the planning process involved evaluation of power flow system analysis results, development of alternative strategies (combination of possible upgrade projects), scenario (addressing uncertainties) development and strategy/scenario assessment over a broad range of load levels.

7.6. Generally EHV transmission reinforcements were developed to provide adequate transmission capacity to import power from remote resources. Most new resources to serve forecasted load within the SATS boundary were assumed to be located outside of the SATS area. A few exceptions including the proposed Bowie power plant and other relatively small local projects were considered. Remote resources that may be available beyond the ten year planning horizon had not been clearly defined at the time the SATS analysis was done. Therefore they were simulated by generation at appropriate interface locations as described in Section 12. Scenarios.

8. Study Criteria

Planning standards, criteria and assumptions have a profound impact on the study process, system performance evaluation and resulting planned upgrades. All of the SATS Participants agreed that NERC/WECC Planning Standards must be met. Therefore NERC and WECC Standards, with the effective date of April 1, 2005, existing as of the start of the SATS study were used in the analysis to determine the load serving capability of the SATS interconnected network. A copy of Table I. NERC Transmission Standards – Normal and Emergency Conditions is attached as Appendix B to this report.

Analysis was divided into SATS-wide and by individual participants' local area systems. The SATS-wide analysis consisted of All Lines In Service (ALIS) and N-1. SATS Participants relied on the following for SATS-wide and individual analysis:

8.1. Three to Five-Year Planning Horizon: Remedial Action Schemes (RAS), including load shedding (LS) when allowed, were modeled. SATS-wide analysis evaluated NERC/WECC Category A and Category B conditions. Individual transmission providers conducted analyses of Category C and D contingencies as appropriate on their respective local systems. Thermal limits, voltage deviation of 5%, and minimum voltage of 0.95 p.u. were identified through flagging conditions under which those limits are reached. Criteria for determining when upgrades are required, while conducting detailed area analysis, were based upon individual participants' policy.

8.2. Ten-Year Planning Horizon: Same as Five Year, except that RAS and LS were

not considered for SATS-wide analysis. Individual participants conducted Category C and D contingency analysis as appropriate per the NERC/WECC standards for detailed local area evaluations.

8.3. Twenty-Year Planning Horizon: RAS and LS were not considered for SATS-wide or individual participants' analysis. Individual participants conducted Category C and limited D contingency analysis.

8.4. The SATS-wide analysis was divided between TEP and SWTC. TEP analyzed the 2010 system and SWTC analyzed the 2016 system. In this analysis, system performance was evaluated for All Lines in Service (ALIS) and for single contingencies (N-1). Each transmission owner in the SATS area provided a list of contingencies (115kV and above) for this analysis. Each of these outages was evaluated against WECC and NERC Planning Standards. In the 2010 analysis, existing RAS were evaluated, if provided. For the 2016 time frame and beyond, it was agreed that RAS would not be evaluated for single contingencies.

TEP and SWTC also initially performed detailed analysis on their respective systems for the 2010 and 2016 cases. Emphasis was shifted to 2013 and 2018 cases as the study progressed to reflect lessons learned through the planning process. TEP's detailed analysis included Category C and D[6] contingencies as appropriate on the TEP EHV network. TEP's Category C and D outages were comprised of all pairs of EHV transmission lines and transformers and 138kV transmission outages that are included in TEP's Tie-Open Load Shed (TOLS) system. TEP's Category C outages are EHV transmission elements that share a common right-of-way, share a common breaker, and 138kV main-and-transfer busses. The Category D outages were all the remaining pairs of TEP EHV elements in the singles contingency list.

SWTC performed detailed analysis for normal and contingency conditions. The analysis covered Categories A, B, and C of the NERC/WECC Planning Standards.

[6] Category D analysis was limited to cases that modeled strategies that were deemed most likely to be pursued, but only, with limited application within the ten year planning horizon. Alternative strategies were initially screened based on Category B and C analysis.

8.5. Local criteria varied among the SATS participants. Criteria used by TEP and SWTC for transmission planning in their respective service areas are described in this section. TEP's local criteria, in addition to the NERC and WECC criteria, are shown in Table 1: TEP Pre-Contingency Local Criteria and Table 2: TEP Post-Contingency Local Criteria.

TEP Pre-Contingency Local Criteria	
EHV Voltage Range	1.03 – 1.04 pu, if possible
138kV Average Voltage	1.0210 – 1.0235 pu
Tortolita VAR Flow	Into Saguaro 500
Generator VAR Output	SVC – In Service 0 – 1 MVAr, All units SVC Out of Service 19 – 20 MVAr, Sundt Steam Units 0 – 1 MVAr, Local Combustion Turbines

Table 1. TEP Pre-Contingency Local Criteria

TEP Post-Contingency Local Criteria	
138kV Average Voltage	0.98 – 1.05 pu

Table 2. TEP Post-Contingency Local Criteria

SWTC's internal criteria and power flow analyses standard are shown next with Table 3 below identifying the SWTC voltage criteria used for the steady state voltage assessment.

Bus Voltage Limits for SOUTHWEST TRANSMISSION SYSTEM				
PRE-CONTINGENCY		POST-CONTINGENCY		
High Limit (pu)	Low Limit (pu)	High Limit (pu)	Low Limit (pu)	Delta V (%)
1.05	0.95	1.10	0.90	5

Table 3. SWTC Steady State Voltage Criteria

Table 4 below identifies the SWTC thermal criteria used for the steady state thermal assessment which is typically used in planning studies.

SYSTEM CONDITION	MAXIMUM ALLOWABLE FACILITY LOADING
Pre-contingency (All lines in)	100% of Normal rating
Post-contingency	110% of Normal rating

Table 4. SWTC Steady State Thermal Loading Criteria

The steady state analysis was performed with pre-contingency solution parameters that allowed adjustment of load tap-changing transformers (LTCs), static var devices (SVDs including switched capacitors) and phase shifting transformers. Post-contingency solution parameters only allowed adjustment of LTCs and SVDs (including switched capacitors).

9. Study Methodology and Assumptions

The SATS study is actually several coordinated studies designed to analyze and define the characteristics of the systems within the SATS footprint, and to determine the various options available to the companies prior to the urgent time crunch to meet reliability concerns. Since that is the case each scenario or case has a separate set of assumptions.

For example, long range electrical peak demand needs will have assumed build out to the levels that are presently envisioned by local city and county planners, developers, and other stakeholders. These require making assumptions about load locations and

magnitudes based on existing land use plans and new generation envisioned to support future year estimates. Another Loads and Resources application is the shorter term of lower projected loads and generation. By combining these two extremes the planner can demonstrate possible construction plans which will accommodate both extremes with the best use of scarce resources.

Another example is the application of through flow requirements associated with Renewable Generation under consideration to be developed north of Arizona and/or within Arizona and New Mexico. The current vision includes development of relatively large interstate transmission projects to transmit significant amounts of power through New Mexico, entering Southeast Arizona and continuing to markets west of Arizona. Some of this power is expected to be delivered within New Mexico and Arizona. The balance is assumed to be transmitted to the west across the SATS area. In this case the assumption of 500 MW to 1500 MW injection at Winchester was applied as a best guess of "reality" in the absence of clearly identified and committed power resource and transmission projects. When applied to the cases, this large injection was expected to create an added impact. Treatment of these uncertain proposals is described in greater detail in Section 12. Scenarios.

Coordination among the SWAT study subgroups will increase as more information about potential transmissions projects interconnecting the respective subgroup study boundaries becomes available. Examples include studies to assess the implications of flow-through caused by large transmission projects associated with possible large wind and other generation projects. Information provided through High Plains Express (HPX) and SunZia analyses, when it becomes available, will help to better define subgroup area interconnections. Another example is a proposal by the Southwest Public Power Resource (SPPR) group (described in Section 18) to deliver power from new generating projects to Load Serving Entities (LSEs) in Southern Pinal and Northern Pima Counties. All of these alternatives influence strategic choices and project decisions within the SATS study area.

Finally, concerns that exist today require study of sub-areas within the SATS footprint. These studies of local systems, such as in Cochise County and the Tucson metropolitan areas served by TEP and Trico were conducted with the interaction of all potentially impacted stakeholders in an open, cooperative and interactive mode. Study

assumptions in these cases were tailored to the needs of the specific area(s) under consideration.

Three planning horizon models (ten-year, twenty-year and saturated load level) were created, with assumptions including specified yearly projections of loads and resources. A few cases were also run at the thirty-year load level. Building saturated load power flow cases as the first step provided insights that were not otherwise available, wherein developing saturated models began with a "working hypothesis", running contingency tests, and iterating to reasonable alternative strategies. Using the resulting build-out information helped to identify necessary new substations and associated local interconnecting transmission needed to supply the new substations. In the TEP cases, the local 138kV topology included a few new network paths that were inspired by potential new substations that enhanced transfer capability that was not otherwise identified by building on pre-ten year model base cases. In other words, ultimate build-out as modeled in "Saturation" cases helped to identify projects with a greater likelihood of remaining sustainable beyond the ten and twenty year planning horizons. The specifics of methodology and assumptions follow:

9.1. The long range electrical peak demand needs of the SATS stakeholders were identified and documented. These forecasts were incorporated geographically into the power flow base cases that were initially acquired through SWAT. Individual load serving entities' aggregate peak demand forecasts were used to determine timing associated with load levels at which analysis indicated that system reinforcement would be needed. The sum of the individual aggregate peak forecasts, while not taking diversity into account, also helped to define the amount of new power supply resources needed within the SATS study area. More detail is included in Section 11: Load Forecast.

9.2. The Transmission Planning Process is interactive and iterative. Transmission system adequacy issues are typically identified by conducting power flow studies of the existing transmission network with greater than existing loads modeled. In an ideal world, system issues emerge within the latter part of and beyond the typical capital budget planning horizon. This would allow sufficient time to make informed capital investment decisions, obtain necessary regulatory permits, acquire right-of-way and substation sites, and otherwise facilitate timely and

cost-effective project design, construction and commissioning.

Pre-existing and/or anticipated transmission network limitations were identified through power flow contingency evaluation of network models with known or relatively certain[7] future upgrades represented in the SWAT cases for 2010. In TEP's case, some new capital budget projects were introduced beginning as early as 2010 to address local area thermal load issues. Beyond the capital budget horizon, evaluation of potential system enhancements begins with modeling possible projects as a working hypothesis. In these cases, analysis amounted to identification of system vulnerabilities as the basis to formulate additional logical and realistic reinforcement alternatives.

9.3. Emerging regulatory requirements and regional policies must be taken into consideration. For example, increasing support for renewable resources tends to accelerate changes in the placement and characteristics of new generation and associated transmission. As a result, work performed by the SWAT RTTF identified the potential for relatively large wind and solar projects that were not previously under consideration in Arizona.

In addition, regional studies involving interstate EHV transmission projects to transmit output from large renewable generation projects outside of Arizona are being addressed through the WECC Transmission Expansion Policy Planning Committee (TEPPC). WestConnect is actively involved in coordinating these study efforts between SWAT and adjacent regional groups such as the Colorado Coordinated Planning Group (CCPG) and a recently formed group called the Sierra Sub-regional Planning Group (SSPG) covering northern Nevada and northern California.

The SATS study plan is to continue developing a **transmission plan to serve load in Southeast Arizona**. However, close coordination will be needed to ensure that study assumptions for the SATS study are reasonable and consistent with sub-regional and regional efforts. The SATS Study is a reliability

[7] However, the topology changed significantly from the 2010 SWAT, case due in large part to the Saturated Load Study and related SATS analysis.

study which will feed into the TEPPC regional congestion study process, with TEPPC using their economic models to evaluate renewable resources on the Western Interconnection.

9.4. Ratings used in the Power Flow Cases. For base cases (all lines in service), flows on all facilities are to be less than the normal (or continuous) ratings. For N-1 analysis, post-contingency flows may exceed the continuous rating, but must always be below the emergency rating. Continuous ratings may also be used to screen or identify the first contingency of interest for N-1-1 study work. Those N-1 contingencies exceeding the continuous rating were then "system adjusted" to reduce post contingency flows to be within the continuous rating in preparation for the next contingency. Generally, facility loading should be less than continuous ratings with all lines in service. Loading may exceed continuous, but always be less than emergency under contingency conditions. N-1-1 criteria state that loading should be reduced to continuous following "system adjustment" (typically within 30 minutes) following the first outage (e.g.N-1) in anticipation of the next contingency.

9.5. Analysis based on the 2016 SWAT power flow case began with an assessment of the SATS area model. Alternative projects were considered, as the ten year case included projects that are under consideration but not necessarily committed. Hence the 2016 cases would incorporate a combination of "committed" and "planned" projects. Committed projects are those which may be in current capital budgets or otherwise approved by individual Transmission Providers (TP). Planned projects generally refer to those under consideration beyond the capital budget planning horizon, and which may be competing with other alternatives. The latter projects are included in the catalog of projects.

9.6. A 2018 base case was developed by TEP after substantial progress had been made on the EHV strategies described in Section 19 at the saturation load level. The intention was to prepare an approximate 50% of saturation load case, which correlates to about the year 2018 in the load forecast, to calibrate against the SWAT 2016 base case. This model turned out to be very different from the 2016 SWAT base case. The new case modeled at least eleven more TEP distribution substations with a materially different 138kV configuration resulting.

In January 2008, TEP shifted its focus to work on a 2018 base case based on Strategy C because it minimizes EHV construction within the City of Tucson. Analysis on Strategy C was initially given the highest priority for all load levels to determine the feasibility of this option meeting load serving capability at build-out. Strategy F, a variation of Strategy C was subsequently created as a possibly lower impact and more cost effective alternative. Both strategies are described in this report. These cases also incorporate TEP's revised (January 2008) long term distribution load allocation model to include the new substations that were identified in the Saturated Load Study. For instance, the TEP system has 28 load serving substations as of 2008, and there is a potential need for a total of 71 at build-out as shown in Table 5: TEP Load Serving Substations. The process of arriving at the new ten year base cases entailed creating a revised Saturated Load case, reducing loads to the 2018 forecast, and removing substations and associated transmission lines that were designated to be in service later than 2018. Saturation model and power flow case building are described in Section 10. Saturated Load Study. Generally, the Saturated Load and 2018 case analysis sequence started with N-1 to ensure no overload violations for the preliminary design. The next step was to conduct an N-2 analysis, using these results to decide on options to either mitigate overloads with strategic load shed[8], or other operating measures, assuming low probability independent events cause the overload. Otherwise system reinforcements were assumed to be in place. This SATS study identified potential alternative system additions that SWTC and TEP may consider in their respective ten year planning efforts. Regardless, the preference is to reinforce the system with additional projects in the ten year planning horizon.

9.7. The plan to develop a 2026 case was subsequently revised to 2028, to simulate and test alternative transmission upgrade strategies. Work on the 2028 case was less rigorous than on the ten year horizon analysis. Base cases were prepared emphasizing EHV Strategies C and F. Case building was similar to the method used for 2018, beginning with the Strategy C Saturation case, reducing

[8] Strategic load shed is intended to be operator initiated, or potentially automated load interruption to relieve thermal HV facility overloading caused by certain low probability multiple contingencies wherein there is sufficient time to system adjust by load shedding.

loads and eliminating substations and associated lines as appropriate. Most of this work was completed in early 2008 in accordance with the SATS 2008 Transmission Study Plan. Situation analysis for all cases consisted of iterative analysis of hypothesized transmission projects to arrive at alternative system configurations that satisfy N-1 criteria. Certain multiple contingencies were also evaluated to identify outages that should be evaluated further depending on impact and/or likelihood of the event. Developing models beyond the typical ten year planning horizon requires critical and innovative thinking about how to most realistically represent the system external to SATS. Information derived through strategy, scenario and saturation study base case development served as an important guide for 2028 and Saturation case development.

The following table shows the existing and potential new TEP load serving substations indicated as additions by load level:

TEP Load Serving Substations	
Planning Horizon	**Number Existing[9] & Potential New Substations**
Existing as of 2008	28
2013	11
2018	9
2028	17
2038	6
Total	71

Table 5. TEP Load Serving Substations

Projects needed to get power flow solutions for between double and triple the existing load level are very different from options that were previously under consideration for the ten year planning horizon. Therefore, reasonable saturation strategies offer valuable insights for projects to include in the 2028 and 2018 cases. More detail on strategy development is included in Section 19: Long-Term SATS and Individual Transmission Provider Strategies.

[9] Two new substations were added for a total of 28 in 2008.

10. Saturated Load Study

General land use information obtained from local jurisdictions in the TEP service territory was used to develop geographically distributed peak demand data assuming ultimate build-out. This data was analyzed to identify likely locations for new distribution substations as well as expansion of existing stations. Alternative local area transmission lines were then evaluated to interconnect these new and expanded substations and integrate them into the existing local network. This exercise helped to identify potential future substation locations and transmission corridors needed to serve local loads.

Saturation data are used in the power flow model, first to determine the feasibility and performance of options for interconnecting new substations. The next step was to evaluate the response of the local area network to alternative EHV strategies to ensure adequate load serving capability is available based on meeting NERC standards. Materially different alternative EHV strategies were prepared to respond to long-range future uncertainty. At this point in the study process it became necessary to integrate saturation with scenario and strategy development. The following *example* for the TEP system illustrates the interrelated nature of saturation/scenario/strategy development.

A hypothetical design for a saturation planning horizon 138kV configuration, or 138kV strategy, begins with the list of new and expanded substations identified in the saturated load study. This initial design provides service to all the load serving substations and meets the "all lines in service" and "N-1" criteria considering contingencies on the local network. However, it is necessary to simultaneously design the EHV system to have the capability to transmit over 3,000 MW from remote resources to load centers. This example assumes that certain "mega-projects" would inject 1,500 MW to 3,000 MW into the Tucson metropolitan area with 1,000 MW to 2,000 MW coming from the Phoenix direction, 1,000 MW to 1,500 MW injected at Winchester, and approximately 500 MW to 1,000 MW from hypothetical new generation south and/or southeast of Tucson. Transmission development assuming this "Balanced Resources" scenario (e.g. three scenario generation injections from the northwest, south and southeast of Tucson) would be significantly different from that required to import resources assuming a "NW & SE Resources" scenario, which would exclude generation south of Tucson. In the "NW & SE Resources" scenario, generation otherwise coming from south of Tucson would be allocated between the NW and SE.

The location of the postulated remote resources, and the EHV project(s) needed to deliver them influence the EHV design, while the EHV design in turn impacts the 138kV local system design. The following diagram, Figure 5: Example Scenario Influence Diagram illustrates the relationship among the various scenarios and suggests the dependence of HV system design on EHV design decisions.

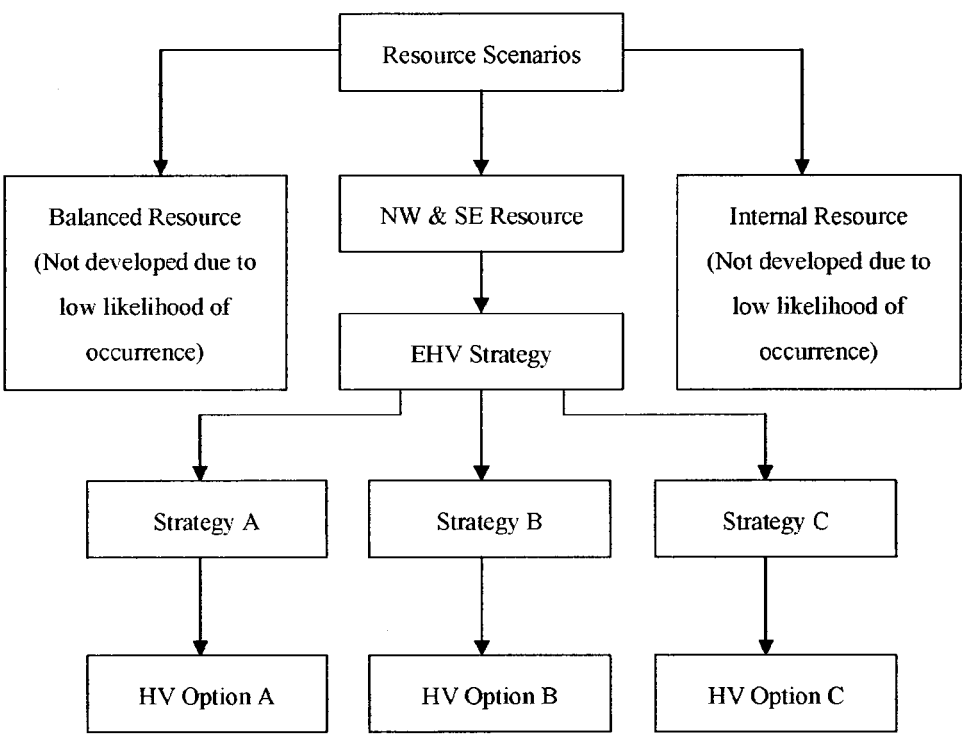


Figure 5. Example Scenario Influence Diagram

Full development of strategies assuming either the "Balanced Resources" or "Internal Resources" scenarios was not pursued at this time due to the relatively low probability that either scenario might occur. "Balanced Resources" was assigned a low probability because generation development south of Tucson was viewed as unlikely by the SATS participants. The "Internal Resources" scenario was deferred because emission restrictions could limit significant new generation development in the Tucson

metropolitan area. Also one of the SATS study objectives was to have a transmission plan based on importing power from remote resources. This plan would then be used as the benchmark to measure deferral or elimination of potential transmission upgrades associated with new local generation. Because of the perceived higher likelihood, a higher priority was placed on analyzing "NW & SE Resources", and sensitivity study of the "Balanced Resources" option was deferred. Refer to Section 12: Scenarios. Further analysis of the "Balanced Resources" scenario may be done if and when definitive plans to develop resources south of or internal to Tucson begin to materialize. However, limited sensitivity analysis was done to determine what impact various generation or "Internal Resources" scenarios may have on possible deferral or elimination of transmission projects.

With respect to the "NW & SE Resources" scenario, three possible decisions about which EHV design to consider are modeled in the decision node labeled "EHV Strategy" shown in Figure 5: Example Scenario Influence Diagram. Each of the EHV decisions, in turn, influence local HV system design (e.g. HV Option" decision node).

11. Load Forecast

Peak demand forecasts for the 10-Year and 20-Year Planning Horizons are required from each of the SATS participants to meet their respective internal strategic planning, regional planning and regulatory requirements. All participants with load serving responsibility provided "base" or "nominal" 20-Year peak demand forecasts including geographic allocation in the power flow databases. WESTERN does not prepare load forecasts because it does not serve retail customers directly, and therefore relies on the forecasts of the Load Serving Entities. Aggregate 20 year forecasts for loads in the SATS area that were provided by APS, CAP, SWTC and TEP are included in Appendix D. Load Forecasts. Note that Unisource Energy loads in Santa Cruz County that are currently supplied from the WESTERN system are planned to be served from the TEP network at the Vail substation by 2012. The peak demand forecast for this area ranges from approximately 90 MW in 2012 to about 125 MW in 2028.

Individual forecasts were summed, or "stacked" one on top of the other with TEP at the bottom, SWTC added on, and so on. The SATS forecast is shown in Figure 6 below. Note that summing the individual forecasts does not take diversity into account.

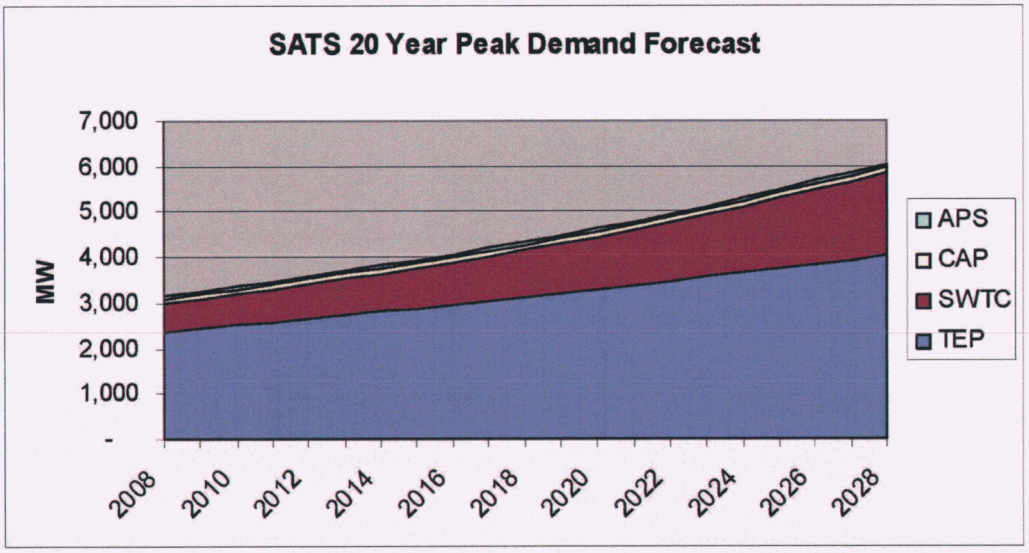


Figure 6. SATS 20 Year Peak Demand Forecast

A general observation is that the load in the SATS area is expected to nearly double in a little over twenty years. This indicates that new resources on the order of 3,000 MW will be needed to serve Southeast Arizona.

11.1. The validity of long-range load forecasts may be assessed by back-casting from saturation load levels and comparing those results against projections based solely on historical trends combined with econometric and other forecasting mechanisms. TEP compared results of the saturated load study against its trended 20-Year forecast. The 2008 TEP peak demand forecast for the Tucson area indicates the load will be approximately 4,000 MW by 2028, or about 170% of current demand. Trending the forecast beyond 2028 suggests that saturation could be achieved somewhere in the vicinity of forty years into the future. Generally the forecast and saturation study are consistent with each other, and both appear to be realistic.

Saturated Load Study correlation to TEP's load forecast is shown graphically in the following chart, Figure 7: TEP Peak Demand Forecast and Saturation Load for the Tucson Area.

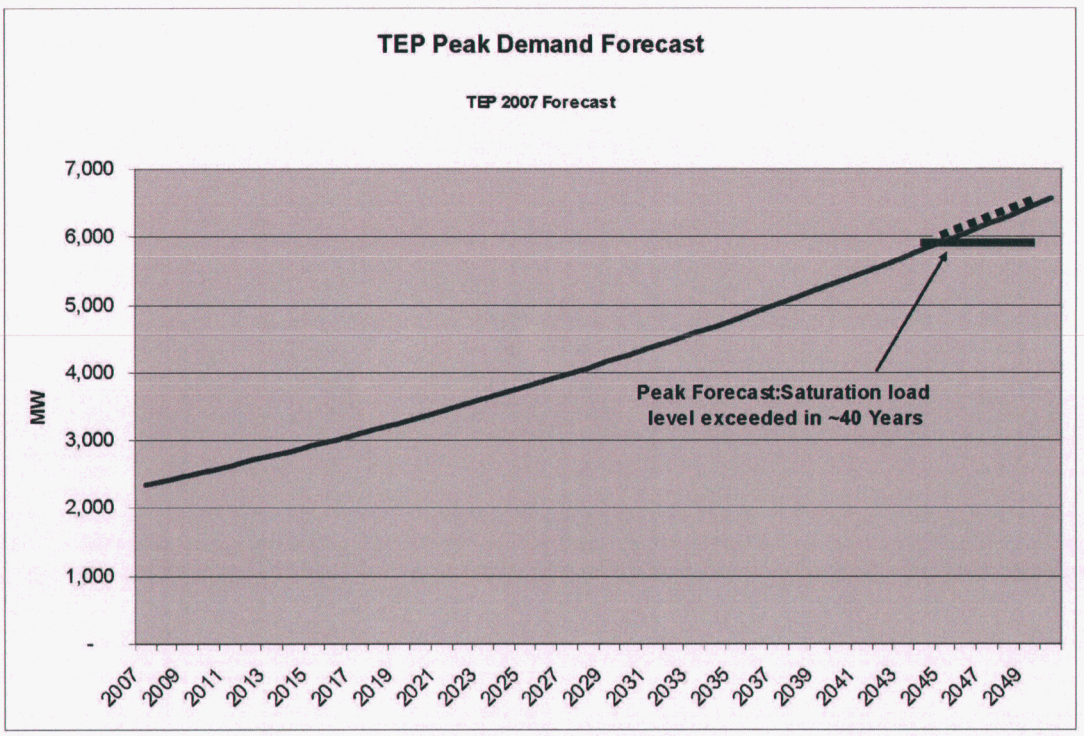


Figure 7. TEP Peak Demand Forecast and Saturation Load for the Tucson Area

There is substantial uncertainty in both the peak demand forecast and saturated loads. Note that Figure 7 shows the TEP peak demand forecast that was completed in 2007. This graphic was not updated to the 2008 forecast because it was very close to the 2007 forecast, and it accurately illustrates the point that saturated load may be achieved in the 40 year time frame. Forecast uncertainty is attributed to the assumption that the economy will continue to expand based on limited information about future events. The saturation study was based on existing jurisdictional land use plans, which the jurisdictions will most likely change as time goes on. Such changes will undoubtedly result in saturation loads being different, but whether they are higher or lower is unknown. Hence the need to conduct sensitivity analysis on load forecast and other assumptions.

A comparison of the TEP System[10] Peak demand forecast for January 2008

[10] Note that the TEP Retail System Peak is defined as the sum of power flows into the TEP Tucson area at the Tortolita, Vail and South Loop EHV points of interconnection plus local area generation. Hence Retail is distinguished from Bus Peak in that 138kV system losses are included in the former.

against a July 2008 revision wherein assumptions such as price elasticity and revised economic indicators shows that load growth may be depressed by a significant margin. These two forecasts provide a range for which projects slated to be in service beyond the five year planning horizon may be deferred. The project schedules in this study are based on the January 2008 forecast. Revisions to project schedules based on this and other subsequent revised forecasts will be provided in SATS and individual Transmission provider study updates.

The October 2008 forecast suggest that projects contemplated for construction by 2013, 2014 or 2015 could be reconsidered for earlier construction in view of slightly higher five-year term growth. However, new generation sited within local area load pockets, or aggressive efficiency improvement, could conceivably become financially feasible if their implementation were to defer a relatively high cost transmission investment. Such investments could make sense particularly if load growth beyond the five year planning horizon is significantly lower than previously forecasted as shown in Figure 8.

Addition of large industrial load such as new or expanded mining operations were not included in the load forecasts. Information indicating that such new load is possible within the five year planning horizon was received after analysis for this study was completed. Nevertheless, individual SATS Transmission Providers have begun to evaluate some of the proposed operations. These studies are a high priority because the magnitude of demand increase is equivalent to a year or more of forecasted load growth. Addition of such large load increments can materially impact project schedules and, depending of the point of interconnection, could dramatically influence the choice of projects.

These observations highlight the need for plan flexibility.

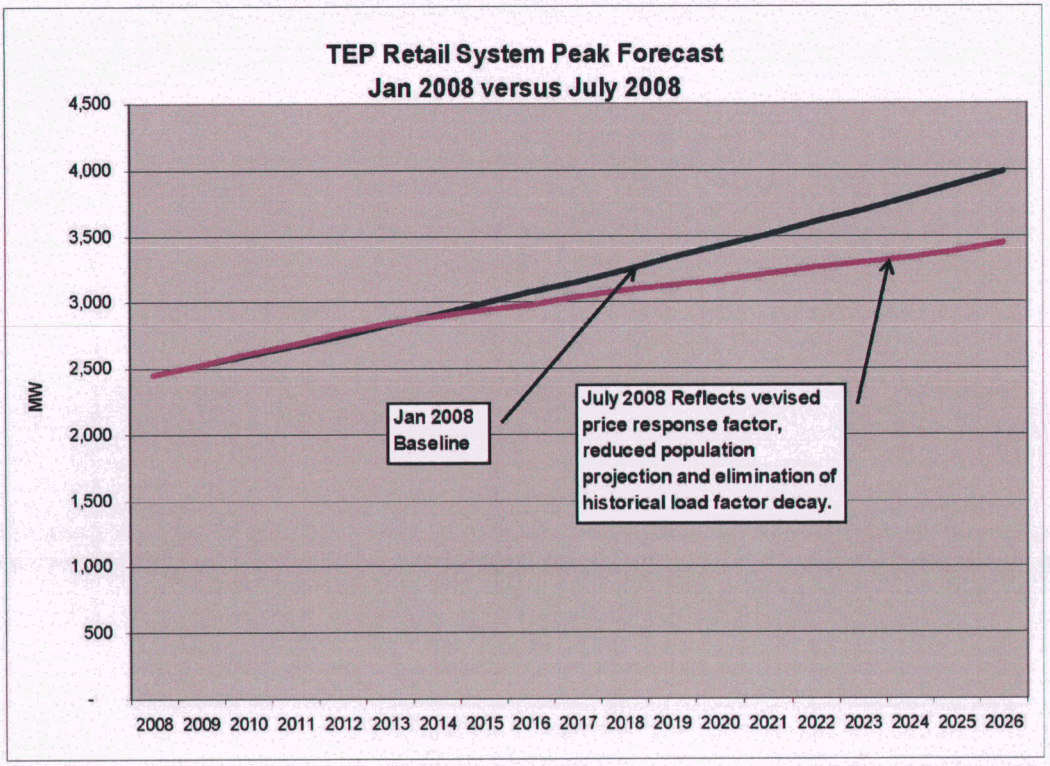


Figure 8. TEP Retail System Peak Demand Forecast Scenarios

Saturated loads were not available for all areas served by SWTC. Only Trico provided a saturated load projection for Marana and the other Trico areas surrounding TEP's service territory. In general, saturation load studies are not done for the SWTC cooperative utilities, as the Members are only required by the Rural Utilities Service (RUS) to do 20 year load forecasts. This requirement is not likely to change anytime soon.

SWTC used a 2025 load forecast for those members that did not provide a saturated load forecast. An econometric model methodology was used to develop the loads within the SWTC member service area. The methodology allowed for medium, low and high peak demand forecasts as shown in Figure 9. SWTC Peak Demand Forecast for the SATS Area. These three forecasted peak demands basically reflect three potential economic states. The SWTC transmission facility requirements were based on the medium economic load projections in this study. The issue of addressing transmission facility additions around a bandwidth of peak demands in a period was not directly taken up at this

time. However some load forecast sensitivities can be inferred from the study to-date since the study worked out a twenty year transmission plan of strategies for the medium load forecast which as seen in Figure 9, contains all but a few high economic peak demands.

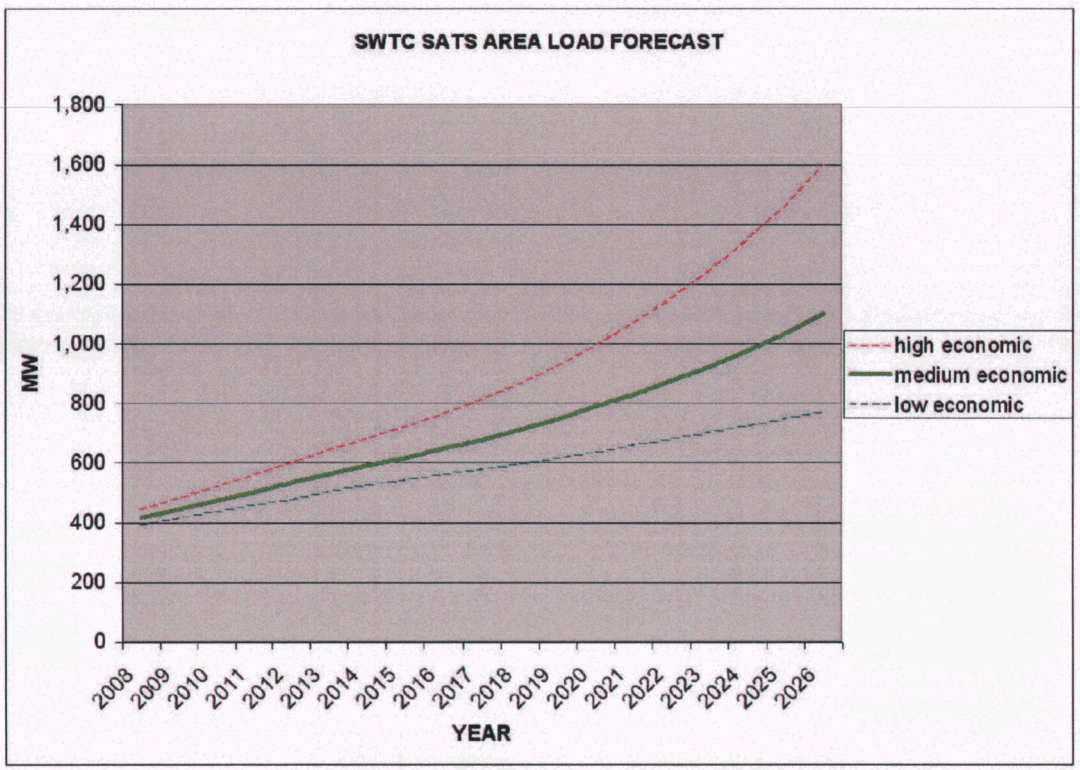


Figure 9. SWTC Peak Demand Forecast for the SATS Area

12. Scenarios

There is general recognition of the need to construct new EHV infrastructure to transmit additional power from new resources into Arizona. Whichever EHV project, or combination of projects is selected, there will be differing impacts on the local area systems in Southeast Arizona. For this reason multiple strategies were developed and modeled. At this time, which of the possible Mega-Projects (TransWest Express, HPX, SunZia, etc.) will be built is unknown. Hence they are treated as study uncertainties. These projects, represented as scenarios in the SATS study are shown below in Figure 10: Potential Mega-Projects Considered for SATS Scenario Import/Injection Locations.

Figure 10. Potential Mega-Projects Considered for SATS Scenario Import/Injection Locations

Scenario Description: Scenarios may be described as reasonably likely future states of the world (where "world" is the Western Interconnection in this case) that influence decisions about which projects or strategies should be pursued. Scenarios are typically characterized by critical uncertainties. The SATS group considers the following list of key uncertainties:

- Generation projects and associated transmission upgrades;
- Merchant or other major EHV transmission projects;
- Load forecast – considering High, Nominal and Low;
- Transmission Line/Substation ROW access;
- Environmental Impact;

- Aesthetic Impact;
- Climate change legislation.

Distinction Between "Scenario" and "Strategy": A sample scenario is presented next to help make the scenario concept clear and to distinguish "scenarios" from "strategies". As an example, assume there is a booming economy with high population growth in Arizona. This suggests a need for additional generation and transmission line projects. One may assume that such development occurs north of Arizona (versus from southern New Mexico) – such as the TransWest Express Project with a 3,000 MW DC terminal in the Las Vegas or Phoenix area. This sample scenario implies a strategy that expedites transmission projects that would supply Southeast Arizona from the Phoenix area. Thus a "scenario" that results in Phoenix becoming a stronger source results in a "strategy" to build transmission from Phoenix to Tucson. This is materially different from a strategy for a scenario that assumed southern New Mexico to be the stronger source.

The SATS group agreed to develop a manageable number of materially different scenarios, perhaps a total of three to aid in thinking about project creation and decisions. Scenarios representing major projects that may or may not be constructed are necessary to simulate projects that introduce new resources either directly into the SATS area or otherwise resources may be imported through potential EHV interconnection(s). Concepts for scenarios that influence strategic thinking are summarized below:

- Manageable Number of Significantly Different Scenarios
  - NW & SE Resources (None from S)
  - Internal Resources
  - Balanced Resources (NW, SE and S)
- Alternative Strategies
  - EHV Ring & EHV Through Urban Areas
  - EHV Ring & EHV Radials into Urban Areas
  - EHV Ring & Heavy HV into Urban Areas
  - Internal SATS Generation

The scenarios are represented as equivalent generators located at the nodes where these projects are likely to interconnect, or where flows from the projects are likely to

enter the SATS network. The potential Mega-Projects (refer to Figure 10) are in various stages of evaluation or possibly advancing toward commitments to develop. The locations where the various project scenarios are modeled are illustrated in Figure 11. SATS Scenario Import/Injection Locations.

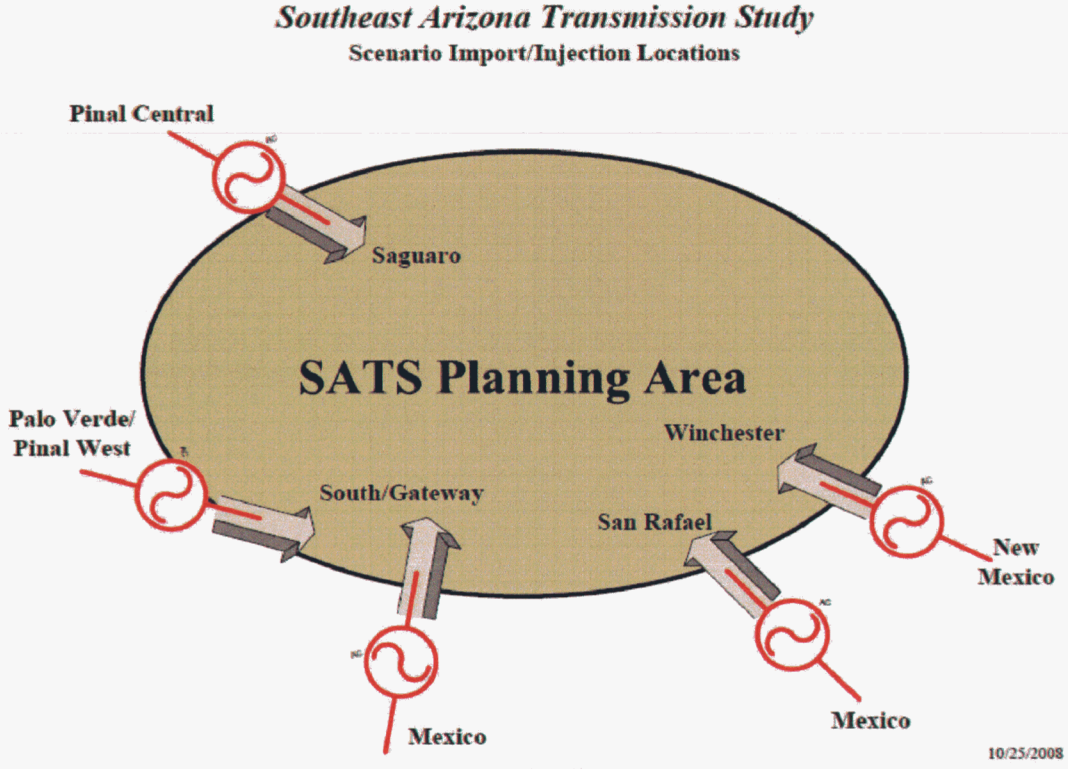


Figure 11. SATS Scenario Import/Injection Locations

The generator locations and magnitude of power output used to model the scenarios, as approved by the SWAT Steering Committee follow:

- Palo Verde (Hassaympa) Up to 1,000 MW
- Pinal West Up to 500+ MW
- Pinal Central Up to 500+ MW
- Winchester Up to 1,500+ MW
- Gateway/Aqua Prieta 500 MW to 1,000 MW

All scenario generators were modeled in the "NW-SE Resources" scenario except Gateway/Aqua Prieta. All injection in this case was therefore assumed to be from

Phoenix and southeastern Arizona. Sensitivity analysis to determine the impact of mega-projects south of Tucson will be accomplished as necessary following this study by turning on Gateway and/or Aqua Prieta and reducing the NW and SE scenario generation.

13. Existing Generation and Maximum Unit Commitment

TEP operates a total of eleven generating units located within its Tucson service area. Four are steam cycles of which one is fueled primarily by coal and the remaining three fueled by natural gas. In addition there are seven combustion turbines fueled by natural gas with oil back up. These units and maximum output are summarized in Table 6. Existing TEP Local Generation.

Existing TEP Tucson Area Generation	
Generator	**Maximum Net Output (MW)**
Sundt Steam 1	77.5
Sundt Steam 2	77.5
Sundt Steam 3	105
Sundt Steam 4	125
Sundt/Irvington CT #1	22
Sundt/Irvington CT #2	22
N. Loop CT #1	22
N. Loop CT #2	22
N. Loop CT #3	22
N. Loop CT #4	17
DMP CT	73
Total	585

Table 6. Existing TEP Local Generation

The four steam units are designated as base load and the DMP CT is base loadable.

The study assumed that the existing four Sundt Steam units and the DMP[11] combustion turbine would be available and operating on peak. Generation from these five units is defined as Maximum Unit Commitment (MUC). Load Serving Capability (LSC) is

[11] DMP was assumed to be operated at reduced output to meet spinning reserve sharing requirements.

defined as the TEP load that could be served by the combination of local generation and transmission with MUC generation operating. Generation that is generally defined as MUC is shown in Table 7.

TEP Maximum Unit Commitment	
Generator	**Assumed Output (MW)**
Sundt Steam 1	77.5
Sundt Steam 2	77.5
Sundt Steam 3	105
Sundt Steam 4	120
DMP CT	44[2]
Total	424

Table 7. Maximum Unit Commitment (MUC) Generation

SWTC does not own or operate generating units. Table 8 shows the generating units that are connected to the SWTC transmission system at the Apache Generating Station. SWTC is required to deliver the output of these units to the participating AEPCO members.

Existing AEPCO[12] Apache Station Generation	
Generator	**Maximum Net Output (MW)**
Apache Steam 1	72
Apache Steam 2	175
Apache Steam 3	175
Apache GT 1	10
Apache GT 2	20
Apache GT 3	65
Apache GT 4	38
Total	555

Table 8. Existing AEPCO Apache Station Generation

[12] AEPCO is Arizona Electric Power Cooperative. SWTC provides transmission service and transmission planning for AEPCO. SWTC reports AEPCO generating unit data to WECC for system planning.

14. Existing Transmission

The SATS EHV, 230kV, 138kV and 115kV transmission system is shown below in Figure 12. SATS EHV and Local Area Transmission. This network includes 500kV and 345kV EHV plus 230kV transmission, with local area consisting of 138kV and 115kV transmission. This system is described and tabulated in detail in this section.

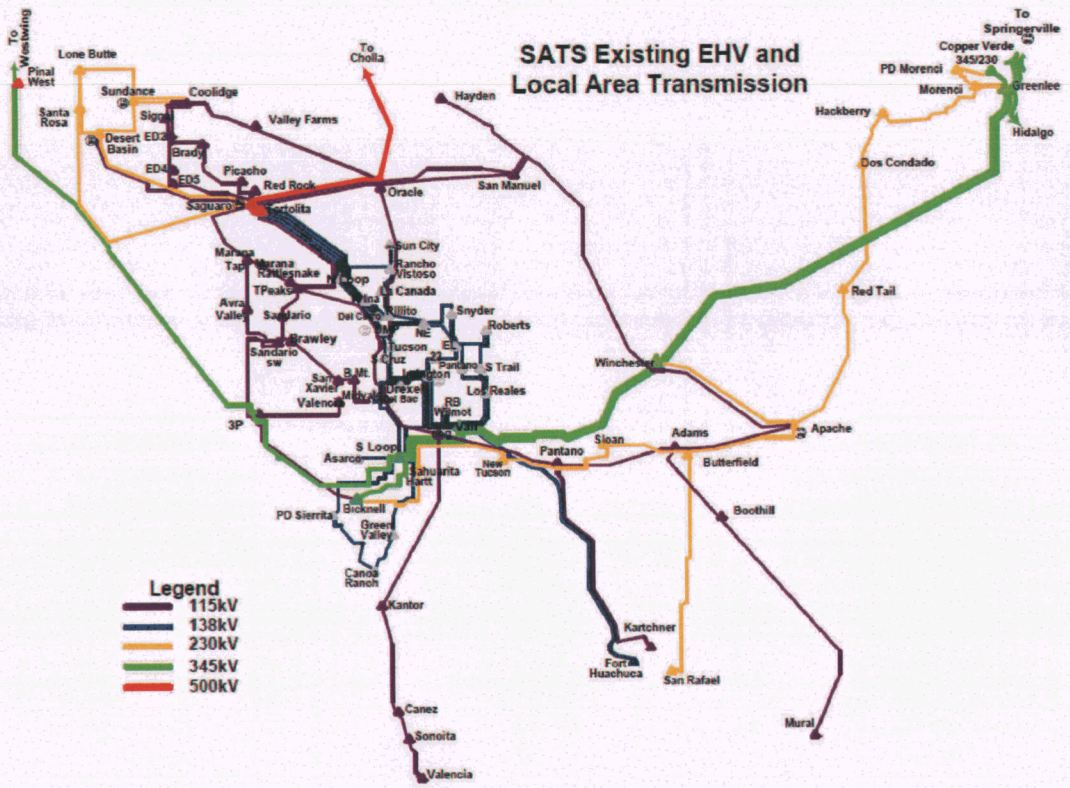


Figure 12. SATS EHV and Local Area Transmission

TEP's existing EHV transmission network, including jointly owned, consists of about 512 miles of 500kV and 1,098 miles of 345kV transmission of which approximately 2 miles and 239 miles of 500kV and 345kV respectively are wholly owned by TEP. The balance of 510 miles of 500kV and 859 miles of 345kV are jointly owned.

A breakdown of these assets is shown in Tables 9 and 10. Table 9 lists the 500kV assets while Table 10 shows the 345kV facilities.

Existing TEP 500kV Transmission Lines[13]		
Description	**Length (Miles)**	**Note**
Saguaro – Tortolita 500kV 1	1.02	TEP Owned
Saguaro – Tortolita 500kV 2	1.02	TEP Owned
Navajo – Moenkopi 500kV	76	Jointly Owned
Moenkopi - Westwing 500kV	179	Jointly Owned
Navajo – Westwing 500kV	255	Jointly Owned
Sub Total	510	Jointly Owned
Sub Total	2	TEP Owned
Total	512	TEP and Joint

Table 9. Existing TEP 500kV Transmission Lines

[13] Source: FERC Form 1 Mileage Report Year Ended December 31, 2007

Existing TEP 345kV Transmission Lines[14]		
Description	**Length (Miles)**	**Note**
San Juan - 4-Corners 345kV	10.5	Jointly Owned[15]
San Juan – McKinley 345kV	90.5	Jointly Owned - Circuit 1
San Juan – McKinley 345kV	90.5	Jointly Owned - Circuit 2
McKinley – Springerville 345kV	107.4	Jointly Owned - Circuit 1
McKinley – Springerville 345kV	107.4	Jointly Owned - Circuit 2
Springerville – Coronado 345kV	21.8	Jointly Owned
Springerville – Vail 345kV	239.1	Express Line – TEP Owned
Springerville – Greenlee 345kV	110.3	Jointly Owned
Greenlee – Winchester 345kV	88.2	Jointly Owned
Winchester – Vail 345kV	40.4	Jointly Owned
Westwing – South 345kV[16]	178.5	Jointly Owned
South – Vail 345kV	13.7	Jointly Owned
Sub Total	859	Jointly Owned
Sub Total	239	TEP Owned
Total	1098	TEP and Joint

Table 10. Existing TEP 345kV Transmission Lines

The particulars on the existing SWTC EHV and 230kV transmission lines are shown in Table 11.

[14] Source: FERC Form 1 Mileage Report Year Ended December 31, 2007

[15] TEP also has rights on the San Juan – Shiprock – Four Corners lines along with the Four Corners – San Juan line making up the 345kV triangle.

[16] The Pinal West project consisting of a Hassaympa to Pinal West 500kV line plus a new 500/345kV interconnection to the Westwing to South Loop 345kV is to be completed in 2008.

Existing SWTC EHV & 230kV Transmission Lines		
Description	**Length (Miles)**	**Note**
Westwing – South 345kV[11]	178.5	Jointly Owned
South – Vail 345kV	13.7	Jointly Owned
Bicknell – Vail 345kV	23.6	SWTC Owned
Greenlee – Greenlee 345kV	0.44	SWTC Owned
Greenlee – Morenci 230kV	6.4	SWTC Owned
Morenci – PD Morenci 230kV	6.8	SWTC Owned
Morenci – Hackberry 230kV	27.2	SWTC Owned
Hackberry – Dos Condado 230kV	7.5	SWTC Owned
Dos Condado – Red Tail 230kV	33.0	SWTC Owned
Red Tail – Apache 230kV	23.9	SWTC Owned
Apache – Winchester 230kV	20.9	SWTC Owned
Apache – Butterfield 230kV	16.0	SWTC Owned
Butterfield – Pantano 230kV	31.0	SWTC Owned
Pantano – Sahuarita 230kV	25.7	SWTC Owned
Sahuarita – Bicknell 230kV	12.0	SWTC Owned
Butterfield – San Rafael 230kV	37.0	SWTC Owned
Davis Dam – Riviera 230kV	8.9	SWTC Owned
Schrader - Corbell 230kV	7.8	Jointly Owned
Schrader – Santan 230kV	13.6	Jointly Owned
Sub Total	213.6[17]	Jointly Owned
Sub Total	280.3	SWTC Owned
Total	493.9[18]	SWTC and Joint

Table 11. Existing SWTC EHV & 230kV Transmission Lines

The integrated APS, SWTC and WESTERN 115kV transmission facilities interconnect with the adjoining SWTC 230kV system. A significant portion of the 115kV system is networked with and is parallel to the 230kV lines. However, there are also a number of radial lines serving loads in the SATS area.

[17] Of the total 213.6 miles SWTC portion is 46.7 miles. SWTC owned 24% of Westwing – South – Vail 345kV, 2.763% of Schrader – Corbell 230kV and Schrader – Santan 230kV lines.
[18] See footnote 3 for SWTC ownership explanation.

Existing CAP 115kV Transmission Lines		
Description	**Length (Miles)**	**Note**
Red Rock – Saguaro East	1.29	CAP – USBR
Picacho – Red Rock	17.59	CAP – USBR
Brady - Picacho	4.51	CAP – USBR
ED-2 - Brady	12.27	CAP – USBR
Rattlesnake – Black Mountain	23.9	CAP – USBR
Black Mountain – Del Bac	7.2	0.7 Miles to be completed
Total	66.67	CAP – USBR

Table 12. Existing CAP 115kV Transmission Lines

Existing WESTERN 115kV Transmission Lines		
Description	Length (Miles)	Note
Lone Butte – Test Track	20.5	Parker Davis - WESTERN
Test Track – Casa Grande	15.1	Parker Davis - WESTERN
Empire – Casa Grande	43.4	Parker Davis - WESTERN
ED-5 - Empire	9.2	Parker Davis - WESTERN
ED-4 – ED-5	9.2	Parker Davis - WESTERN
ED-2 – ED-4	9.3	Parker Davis - WESTERN
ED-2 - Signal	4.3	Parker Davis - WESTERN
Coolidge - Signal	7.9	Parker Davis - WESTERN
Saguaro West – ED-5	17.1	Parker Davis - WESTERN
Coolidge – ED-2	11.5	Parker Davis - WESTERN
Saguaro East - Oracle	19	Parker Davis - WESTERN
Valley Farms - Oracle	39.5	Parker Davis - WESTERN
Coolidge – Valley Farms	5.2	Parker Davis - WESTERN
Tucson - Oracle	25.37	Parker Davis - WESTERN
Saguaro East – Marana Tap	11.63	Parker Davis - WESTERN
Marana Tap - Rattlesnake	7.62	Parker Davis - WESTERN
Rattlesnake - Tucson	16	Parker Davis - WESTERN
Tucson – Del Bac	10	Parker Davis - WESTERN
Del Bac - Nogales	10.4	Parker Davis - WESTERN
Pantano - Nogales	23.2	Parker Davis - WESTERN
Adams - Pantano	19	Parker Davis - WESTERN
Adams - Apache	17	Parker Davis - WESTERN
Sub Total	351.42	Parker Davis - WESTERN
Sub Total	35.66	CAP – USBR
Total	387.08	WESTERN and USBR

Table 13. Existing WESTERN 115kV Transmission Lines

TEP's local area network consists of 138kV facilities that supply the Tucson metropolitan region from 500kV and 345kV points of interconnection at the Tortolita, Vail and South Loop substations. Specific TEP 138kV line data are detailed in Table 14. Existing TEP 138kV Transmission Lines as shown in the FERC Form 1 Mileage Report

dated December 31, 2007.

Existing TEP 138kV Transmission Lines		
Description	**Length (Miles)**	**Note**
Tortolita – North Loop Line 117	14.3	954 MCM ACSS
Tortolita – North Loop Line 118	14.3	954 MCM ACSS
Tortolita – North Loop Line 125	14.3	1365 MCM ACAR
North Loop – Rancho Vistoso Line 122	8.0	954 MCM ACSR
North Loop – West Ina	5.8	795 MCM ACSR
North Loop - Rillito	10.1	795 MCM ACSR
Rillito - Northeast	6.2	795 MCM ACSR
Northeast – East Loop	6.9	795 MCM ACSR
East Loop – Roberts Segment 1	2.5	795 MCM ACSR
East Loop – Roberts Segment 2	4.7	795 MCM ACSR
East Loop - Pantano	3.5	795 MCM ACSR
Pantano – Los Reales	8.7	795 MCM ACSR
Los Reales - Vail	4.6	1365 MCM ACAR
Spanish Trail - Vail	12.9	1365 MCM ACAR
Vail – Fort Huachuca Segment 1	8.1	795 MCM ACSR
Vail – Fort Huachuca Segment 1	43.9	477 MCM ACSR
Irvington – Robert Bills	7.5	795 MCM ACSR
Robert Bills - Vail	3.5	795 MCM ACSR
Irvington - Vail	11.1	795 MCM ACSR
Midvale – South Loop	12.4	795 MCM ACSR
Irvington – South Loop	16.1	795 MCM ACSR
Drexel - Irvington	2.5	795 MCM ACSR
South Loop – AS&R Mission	5.6	795 MCM ACSR
South Loop – Duval, Cyprus	15.1	795 MCM ACSR
Tucson Station - Irvington	10.9	795 MCM ACSR
Santa Cruz - DMP	3.9	795 MCM ACSR
North Loop – DMP	14.9	795 MCM ACSR
Saguaro – Tortolita 1	1.2	795 MCM ACSR
Saguaro – Tortolita 2	1.2	795 MCM ACSR

Existing TEP 138kV Transmission Lines		
Description	**Length (Miles)**	**Note**
West Ina – Tucson Station	10.6	795 MCM ACSR
DMP - Northeast	5.7	1365 MCM ACAR
Roberts – Spanish Trail Segment 1	3.2	795 MCM ACSR
Roberts – Spanish Trail Segment 2	2.5	795 MCM ACSR
Rillito – La Canada	5.4	954 MCM ACSR
Irvington – Santa Cruz	9.8	795 MCM ACSR
East Loop – Snyder Segment 1	3.4	954 MCM ACSR
East Loop – Snyder Segment 2	.8	477 MCM ACSR
East Loop – Snyder Segment 3	1.1	795 SSAC
Midvale - Drexel	6.4	954 MCM ACSR
Green Valley – Cyprus Raw Water	4.3	954 MCM ACSR
Irvington – 22nd Street	3.4	954 MCM ACSR
South Loop – Green Valley	14.7	954 MCM ACSR
La Canada – Rancho Vistoso	5.2	954 MCM ACSR
Northeast – Snyder Segment 1	2.5	477 MCM ACSS
Northeast – Snyder Segment 2	.3	795 MCM ACSR
Northeast – Snyder Segment 3	2.0	477 MCM ACSS
Northeast – Snyder Segment 4	2.0	477 MCM ACSR
Northeast – Snyder Segment 5	1.3	795 MCM ACSR
East Loop – 22nd Street	4.6	477 MCM ACSS
Total	362.5	

Table 14. Existing TEP 138kV Transmission Lines

Figures 13 and 14 show the current transmission configuration for the northern and southern portions respectively of TEP's existing 138kV system serving the Tucson area.

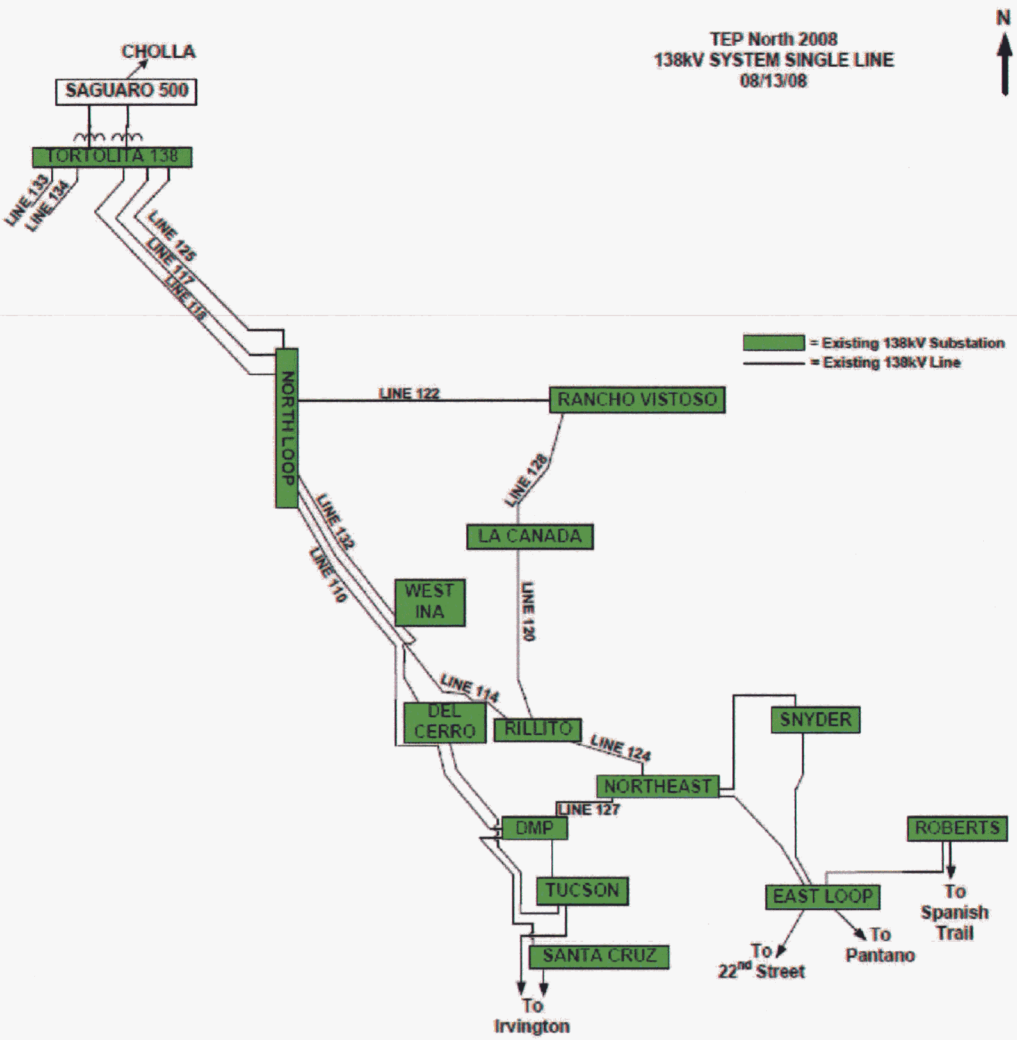


Figure 13. Northern TEP 138kV System as of 2008

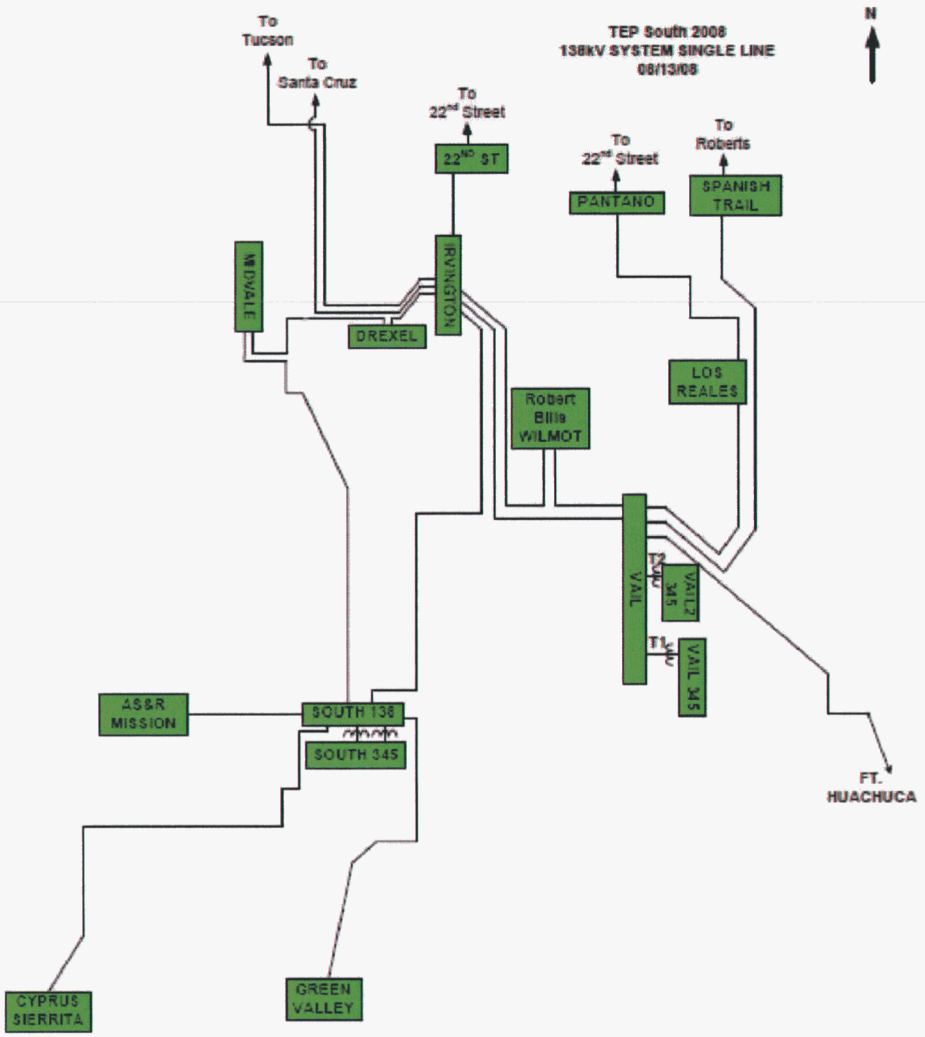


Figure 14. Southern TEP 138kV System as of 2008

15. Characteristics of SATS Transmission System

The SATS participants recognized that transmission loading issues, based on applicable load forecasts, will require relatively extensive upgrades in or about the five year planning horizon. There are a number of solution approaches and timing alternatives among which to choose. Therefore SATS formed a transmission planning subgroup to focus on understanding the issues and to begin formulating a means to identify optimal solutions and to help coordinate potential project decision making. The subgroup is generally looking at three areas, with the objective of integrating solutions among the three areas. The areas and their respective characteristics and potential

solutions are shown in Figure 15 and described in the narrative that follows:

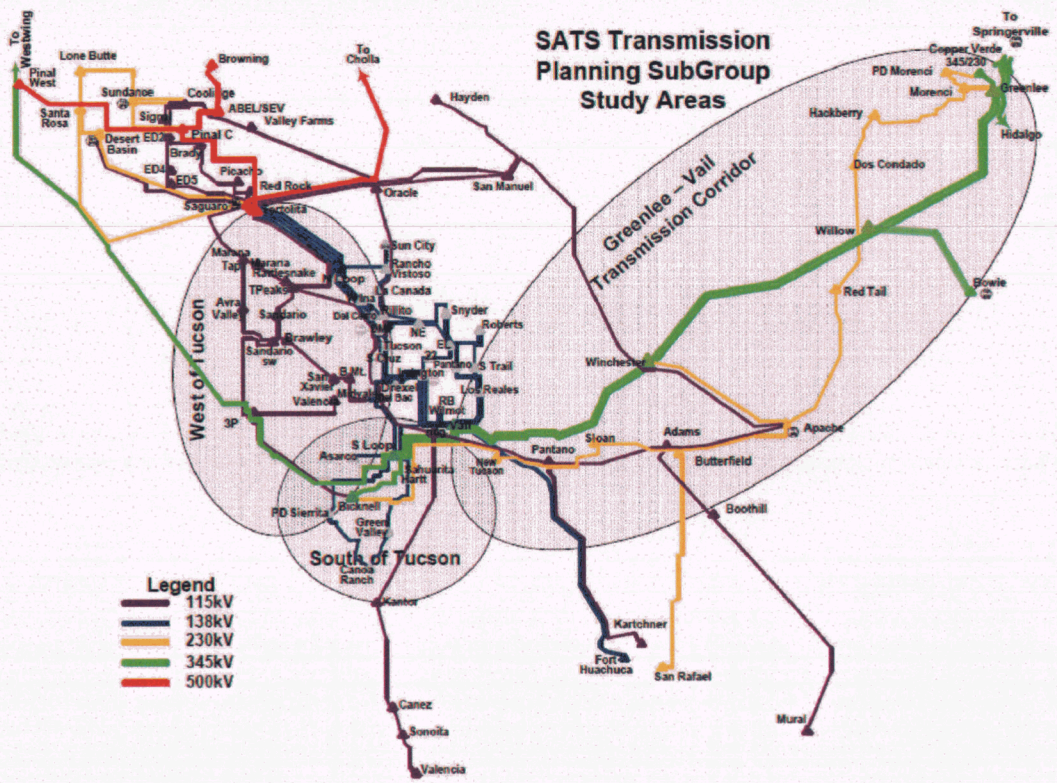


Figure 15. SATS Transmission Planning SubGroup Study Areas

15.1. Greenlee to Vail EHV and 230kV Corridor Area

Characteristics: This area includes two 345kV lines in parallel with an interconnected 230kV system. Key features are:

15.1.1. Loads are increasing stress on the parallel 345kV and 230kV transmission lines. Critical contingencies include the loss of various combinations of 345kV lines between Springerville and Vail.

15.1.2. WESTERN owns a significant portion of the 115kV system paralleling the SWTC 230kV lines from Apache into Tucson. Limitations associated with this 115kV system are not clearly understood at this time.

15.1.3. A new 500 MW generator is proposed to be interconnected at a new Willow 345kV switching station to be located on the Greenlee - Winchester 345kV line at the point where the Dos Condado - Red Tail

230kV line crosses. This power plant may become an important resource to supply growing area loads, but will require certain EHV, and possibly other local system reinforcements. Critical contingencies involve loss of the Express Line and any portion with either the Winchester - Vail 345kV, Willow - Winchester 345kV, Greenlee – Willow 345kV lines. Another critical outage combination is the Greenlee – Willow and Winchester – Vail 345kV lines. The SATS group will focus on solving these concerns in the 2009 SATS Study plan.

15.1.4. The Apache to Winchester portion of the115kV line from Apache to Hayden is constructed at 230kV. Conversion to 230kV operation may be accomplished by adding 230/115kV transformation at Winchester to supply SWTC load to Hayden, and possibly addition of a second 345/230kV transformer at Winchester.

15.1.5. The Copper Verde 345/230kV transformer overloads and is sensitive to outage of 345kV line segments north and south of Greenlee. Freeport McMoRan (FMI) plans to add a second parallel transformer in 2009.

15.1.6. FMI plans to increase Morenci area load. The Hackberry load is expected to be 100 MW by 2011. The PD Morenci load has been reported to increase from approximately 200 MW to 260-280 MW by 2008, and to 440-480 MW in the 2009/2010 time frame.

15.1.7. Apache generation station may be considered for generation expansion.

15.1.8. SunZia Project has announced plans to be in service by 2013. This project should be evaluated. Interconnection at Winchester, were it to occur, would require EHV reinforcement.

Potential Solutions: Alternatives to mitigate overloads caused by critical contingencies include the following:

15.1.9. New 345kV Winchester – Vail double circuit line

15.1.10. New 345kV Willow – Winchester double circuit

15.1.11. Winchester – Tortolita 500kV line

15.1.12. Uprate 230kV Apache – Bicknell line

15.1.13. Convert Apache – Winchester 115kV to 230kV (Includes 230/115kV transformation at Winchester)

15.1.14. Add 2nd 345/230kV transformer at Winchester

15.1.15. Add 345/230kV interconnection at Willow station (Possible mitigation for increasing PD Morenci load)

15.1.16. Add new 230kV San Rafael – Kartchner (or Ft Huachuca) line and rebuild to Pantano (or a new 230kV interconnection farther west, such as Bicknell).

15.1.17. Rebuild the WESTERN 115kV line to 230kV from Apache to a location somewhere in the vicinity of the Nogales Tap. A site is to be identified to terminate the proposed new 230kV line with transformation as appropriate to 115kV to maintain continuity of the Parker-Davis system. Options to integrate the new 230kV line with the SWTC, TEP, Trico and WESTERN systems include interconnection with existing 230kV and/or transformation to 345kV and 138kV facilities.

15.1.18. Measures being studied to mitigate overloads on the Apache to Bicknell 230kV line include:

15.1.18.1. Reconductoring portions of the 230kV line from Apache to Butterfield in combination with a loop-in at Pantano of the WESTERN 115kV line. The latter places the 115kV line in parallel with the Butterfield to Pantano line.

15.1.18.2. Install a Phase Shifting Transformer (PST) near Bicknell, Butterfield or other location on the 230kV line to regulate post-contingency flows on the Apache to Bicknell 230kV line.

15.1.18.3. Install a PAR on the Pinal West – South Loop 345kV line on the west side of the South Loop substation to regulate post-contingency flows on the Apache to Bicknell 230kV line.

15.1.18.4. Tripping the Bicknell transformer

15.1.18.5. Reducing or tripping Bowie generation

15.1.18.6. Looping-in the Springerville – Vail Express line in at Willow or Winchester for emergency operation only.

15.1.18.7. Other options.

15.2. South of Tucson Area

Characteristics: Service to this area is relatively evenly divided between TEP and Trico. Therefore opportunities for cost-effective joint load serving substation expansion within this area appear to be greatest. This area includes two parallel

345kV lines, with a 230kV line parallel to the 345kV lines. Key features are:

15.2.1. The Vail – Bicknell 345kV SWTC line passes close by the South Loop substation. A critical contingency is loss of the Vail – South Loop 345kV line, potentially causing overloads on the parallel 138kV system.

15.2.2. A 230kV line from Pantano, which parallels a significant portion of the WESTERN 115kV line to Del Bac, terminates at the Bicknell station. Possible loop-in at South at either 230kV or 345kV could provide mutual benefits.

15.2.3. There are two transformations at Bicknell, 345/230kV and two 230/115kV. The 115kV terminal supplies the SWTC line to CS1 located near Three Points.

Potential Solutions: A new 345kV or 230kV transmission interconnection to the local area 138kV or 115kV transmission could be cost effect alternatives to expanding local area transmission to serve increasing local load. This proposal may be a jointly owned project. Looping-in 345kV or 230kV could defer or eliminate the need for additional new 345kV or 230kV transmission. Alternatives follow:

15.2.4. Loop-in the Vail – Bicknell 345kV line at South Loop. This relieves post-contingency loading on the 138kV system. Need to conduct detailed analysis and determine land availability and permitting requirements.

15.2.5. Loop Pantano – Sahuarita 230kV line into South Loop. Possible multiple benefits include loading relief on the Apache – Butterfield 230kV line, stronger source for Bicknell and/or new joint distribution substation east of Bicknell. Need to conduct detailed analysis and determine land availability and permitting requirements.

15.2.6. New Three Points – Bicknell 345kV or 230kV line. Possible benefits may be available through increased transfer capability between South of Tucson Area and West of Tucson Area during contingencies.

15.2.7. New joint load serving substation on the Vail – Bicknell 345kV line or the Sahuarita – Bicknell 230kV line.

15.2.8. Other options.

15.3. **West of Tucson Area**

Characteristics: The area west of Tucson is served by Trico and TEP. The TEP territory consists of a relatively narrow strip west of I-10 extending from Marana to the San Xavier District of the Tohono O'Odham Nation. The Trico territory is generally west and south west of the TEP service area. Transmission located west of Tucson is provided by CAP, WESTERN, SWTC and TEP. Key features are:

15.3.1. The WESTERN 115kV line, which is sourced from the APS Saguaro station, begins in a southwesterly direction and continues southeasterly through the WESTERN Tucson station to Del Bac and beyond into the South of Tucson Area. Continuity of the WESTERN 115kV system is necessary to meet contractual obligations to customers receiving transmission services from WESTERN.

15.3.2. Another WESTERN 115kV line connects Saguaro to Oracle and continues south to the Tucson station. This line is the third side of a 115kV triangle with vertices at the Saguaro, Oracle and Tucson stations.

15.3.3. The CAP system presently is a radial 115kV line supplied by the WESTERN system through an interconnection at Rattlesnake. CAP also has rights to the 115kV transmission facilities connected to the WESTERN system at Del Bac. Radial service subjects the CAP pumping system to N-1 outages.

15.3.4. The SWTC local 115kV system is interconnected to WESTERN at the Marana Tap and the SWTC Bicknell station.

15.3.5. SPPR has proposed a "Three Terminal Project" to deliver new generation output to its participants. One of the three terminals is proposed to connect to the SWTC and WESTERN 115kV systems through a 230/115kV transformation at the Marana Tap station.

Potential Solutions: SWTC and CAP are in the process of integrating their respective systems through planned interconnections at Sandario (near Brawley) and Valencia (near San Xavier). SWTC is also planning to construct a new 115kV line from Saguaro as the 4th circuit on the proposed TEP "Quad" circuit. This new line is to connect proposed intermediate distribution substations along the corridor

to the North Loop substation, and eventually terminate at the WESTERN Rattlesnake station. Alternatives follow:

15.3.6. Saturated load level (build-out) envisions a possible joint double circuit 345kV project between Tortolita and North Loop plus a Vail – Irvington (or SS NO30) – South Loop 345kV project. One of these EHV projects is anticipated to be in service by ~2014 (based on the current 2008 load forecast) unless a local Tucson area generation or other alternative project is identified to defer such an upgrade. A second EHV project would be required within the next 15 to 20 year time frame to maintain adequate load serving capability.

15.3.7. The SPPR Three Terminal proposal presents alternative strategy elements for SATS to develop and evaluate. Introduction of a new 230kV source at the Marana Tap location suggests that a 230kV line (possibly double circuit to retain the WESTERN 115kV line) continuing into Tucson and terminating at a yet-to-be-determined location in either the South of Tucson or Greenlee to Vail Corridor Areas should be evaluated. Intermediate 230/138kV and/or 230/115kV connections at North Loop, DMP, Del Bac, SS NO30 or other location may also be considered.

15.3.8. A new 345/115kV connection at Three Points is an option for reinforcing the integrated SWTC/CAP system.

15.3.9. A new 345 switching station at Three Points with a 345kV line replacing the existing 115kV line to Bicknell could strengthen the tie between the West of Tucson and South of Tucson Areas. An alternative is a new 345/230kV station at Three Points with a 230kV line replacing the existing 115kV line to Bicknell.

15.3.10. An emergency 138/115kV transmission interconnection that was previously considered in the Black Mountain Three Party Agreement may be reconsidered.

15.3.11. Others to be determined.

16. Potential Alternative Projects

Potential alternative projects are listed to provide as complete an inventory as possible of potential projects that may be evaluated individually or jointly as elements of alternative transmission planning strategies. Some may become an integral part of

multiple strategies while others may not receive further consideration at all. Figure 16. SATS EHV Potential Projects shows most of the transmission projects that were brainstormed and discussed in preparation for alternative strategy development. Note that this diagram depicts new 345kV lines from Willow to Winchester and Winchester to Vail plus Vail to Pinal West. While 345kV appears to be adequate to serve SATS load for the twenty to thirty year planning horizon, 500kV alternatives may prove to be feasible depending upon the rate of growth, ultimate build-out and on plans for integrating mega-projects into the SATS area transmission network.

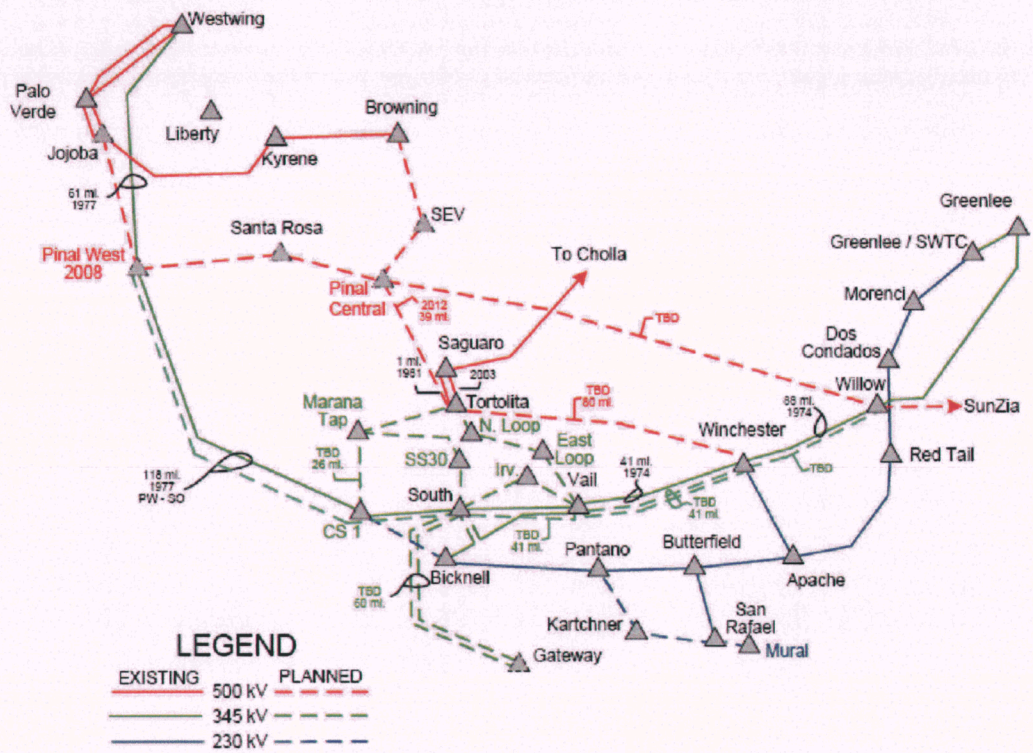


Figure 16. SATS EHV Potential Projects

The projects shown in the above map, and other projects are listed in the following tables.

500kV Potential Projects	
Pinal Central – Tortolita	Winchester/Willow – SunZia Interconnection
Tortolita – Winchester	Vail – South Loop
Pinal Central – Winchester	Pinal West – South Loop
Tortolita – South Loop	Pinal West – Three Points
Winchester – Vail Single Circuit	Three Points – Vail
Winchester – Vail Double Circuit	Willow - Winchester

Table 15. 500kV Potential Projects

Pinal Central – Tortolita 500kV: This project introduces a new 500kV connection to the system serving the Tucson metropolitan area. It also may integrate with future EHV projects needed to deliver proposed wind and solar renewable resources to potential markets in the southwest.

Winchester/Willow – SunZia Interconnection: This project may serve multiple purposes. The Willow 345kV switch yard provides an interconnection for the proposed Bowie Generating Station. Also, Willow is the preferred location for the SunZia project point of interconnection. Winchester may be considered as an alternative point of interconnection.

Tortolita – Winchester/Willow, Pinal Central – Winchester/Willow: These potentially competing projects may add a new 500kV link connecting the Tortolita or Pinal Central sources to the TEP 345kV lines serving Tucson. They are also options to integrate with the SunZia project.

Winchester – Vail Single Circuit, Winchester – Vail Double Circuit, Willow – Winchester: These projects, some of which may be competing, are options to reinforce the 345kV system between the Willow and Vail substations.

Vail – South Loop, Pinal West – South Loop, Pinal West – Three Points, Three Points – Vail: These projects are alternatives, some of which would be competing, that could become links in a larger project to provide a 500kV loop running south around Tucson.

345kV Potential Projects	
Tortolita – North Loop Double Circuit	Tortolita – Marana Tap
Tortolita – North Loop Single Circuit	Marana Tap – North Loop
Tortolita – Rillito	Marana Tap – DMP
Rillito – East Loop	DMP – SS 30
Rillito - Northeast	SS 30 – South Loop
Tortolita - East Loop	SS 30 – Vail
North Loop – Rillito	Three Points – SS 30
North Loop – Northeast	Marana Tap – Three Points
North Loop – East Loop	Three Points – Bicknell
Northeast – East Loop	Vail – South Loop – Bicknell (loop-in)
East Loop – Vail	Vail – Irvington
East Loop - Irvington	South Loop - Irvington
South Loop – Pinal West #2	Vail – South Loop #2
Winchester – Vail Single Circuit	Apache – Vail Single Circuit
Winchester – Vail Double Circuit	Apache – Vail Double Circuit
Willow - Winchester	Pinal West – South Loop PAR

Table 16. 345kV Potential Projects

Tortolita – North Loop Double Circuit, Tortolita – North Loop Single Circuit, Tortolita – Rillito, Rillito – East Loop, Rillito – Northeast, Tortolita - East Loop, North Loop – Rillito, North loop – Northeast, North Loop – East Loop, Northeast – East Loop, East Loop – Vail: These projects are alternatives, some of which are competing, to increase 345kV transfer capacity into the TEP system from the Tortolita and Vail EHV transmission sources. Some of these projects may be viable joint projects.

Tortolita – Marana Tap, Marana Tap – North Loop, Marana Tap – DMP, DMP – SS 30, SS 30 – South Loop: These projects make up alternative projects, some of which are competing, to increase 345kV transfer capacity into Tucson area. Some of these projects may be viable joint projects.

Three Points – SS 30: This project is an alternative to SS 30 – South Loop.

Marana Tap – Three Points: This project would effectively interconnect Tortolita to the Pinal West to South Loop 345kV line, assuming the Tortolita to Marana Tap project were to be built.

Three Points – Bicknell: This project, assuming the Three Points/SC1 345/115kV substation was constructed, would add a new 345kV path in parallel with the existing 345kV line from Vail to Three Points.

Vail – South Loop – Bicknell (loop-in): This project would effectively add a new parallel 345kV line between Vail and South Loop.

Vail – Irvington, South Loop – Irvington: This project would add a new parallel 345kV path between Vail and South Loop. It also is an essential part of a TEP "reach-in strategy" described in Section 19. Long-Term SATS and Individual EHV Transmission Provider Strategies.

Vail – South Loop #2, South Loop – Pinal West #2: These projects would add a new 345kV line in parallel with the existing Pinal West to Vail 345kV line.

Winchester – Vail Single Circuit, Winchester – Vail Double Circuit, Apache – Vail Single Circuit, Apache – Vail Double Circuit: These projects, some of which are competing projects, would add one or two new 345kV circuits in parallel with the existing Winchester to Vail and Springerville to Vail 345kV lines.

Willow – Winchester: This project would add a new 345kV line in parallel with the existing Greenlee to Winchester 345kV line. This project assumes the Willow switching station is in service on the Greenlee to Winchester line.

Pinal West – South Loop PST: This project would insert a phase shifting transformer into the Pinal West to South Loop 345kV line. The primary function of the PAR would be to reduce post contingency flows on the 230kV system that parallels the Greenlee to Vail 345kV line.

230kV Potential Projects	
Three Points – Bicknell	Winchester - Apache
Apache - Butterfield	Butterfield - Pantano
Pantano – Nogales Tap	Nogales Tap – Del Bac
Del Bac - DMP	DMP - Marana Tap
Vail – San Rafael	Pantano – Kartchner – San Rafael
Bicknell – San Rafael	Sloan – Huachuca City
San Rafael - Mural	Adams Tap - Mural
Bicknell – Sahuarita PAR	

Table 17. 230kV Potential Projects

Three Points – Bicknell: This project, assuming the Three Points/SC1 345/115kV line

were constructed, would add a new 230kV path in parallel with the existing 345kV line from Vail to Three Points.

Winchester – Apache (2nd circuit which is currently operated at 115kV), Apache – Butterfield, Butterfield – Pantano, Pantano – Nogales Tap, Nogales Tap – Del Bac, Del Bac – DMP, DMP - Marana Tap: These projects would involve conversion of existing 115kV lines to 230kV, most of which would be along the WESTERN right-of-way. It also appears to be dependent on the SPPR 230kV proposal for a 230kV terminating at the Marana Tap substation.

Vail – San Rafael, Pantano – Kartchner – San Rafael, Bicknell – San Rafael, Sloan – Huachuca City, Bicknell – San Rafael, Sloan – Huachuca City, San Rafael – Mural, Adams Tap – Mural: These projects are alternatives, some of which are competing, to improve reliability for entities in the Cochise County area.

Bicknell – Sahuarita PST: This project would insert a phase shifting transformer (PST) into the Bicknell to Sahuarita 230kV line. The primary function of the PST would be to reduce post contingency flows on the 230kV system that parallels the Greenlee to Vail 345kV line.

138kV Potential Projects	
Tortolita – North Loop Quad (3-138kV)	Marana – SS No 1
Tortolita – Rillito	SS No 1 – North Loop
Tortolita – Marana (TEP – New Corridor)	DMP - Tucson
Marana Double Circuit Tap	Orange Grove – SS NO6
North Loop – Naranja	SS NO6 – SS NO7
Naranja – Rancho Vistoso	SS NO7 – Northeast
Rancho Vistoso - Catalina	Twenty Second – SS NO15
Tortolita - Catalina	Twenty Second – SS NO14
Irvington – Kino	SS NO14 – East Loop
Kino – Downtown	SS NO14 – Northeast
Downtown - Tucson	SS NO4 Tap
SS NO13 Tap	SS NO8 Tap
SS NO16 Tap	Vail – SS NO17
Midvale – Spenser	SS NO15 - Irvington
Vail –SS NO33	SS NO20 Tap
SS NO33 – Swan Southlands	SS NO27 Tap
Swan Southlands – SS NO22	Canoa Ranch – Duval Clear
Hartt – SS NO29	SS NO28 Tap
Canoa Ranch – SS NO25	

Table 18. 138kV Potential Projects

Tortolita – North Loop Quad (3-138kV): This project is included in the TEP five year capital budget. Its primary purpose is to increase transfer capability from the Tortolita Substation into the northern portion of the TEP local area network. It has provisions to add a 115kV SWTC circuit (e.g. the 4th circuit on the Quad) to enhance reliability of the 115kV local area systems as well as to supply proposed new Trico load serving substations.

All other TEP 138kV Potential Projects: These projects are intended, primarily, to integrate new substations identified by the TEP saturated load study into the existing 138kV local area network. Some of these projects would also add new lines as needed to enhance local system transfer capability.

115kV HV Potential Projects	
Saguaro – Naviska – Adonis – Thornydale – Camino de Manana – North Loop	Marana – Naviska
Adonis - Rattlesnake	Sandario (SWTC) – Sandario (CAP)
Sandario (SWTC) - Brawley	Brawley – San Joaquin
San Joaquin – San Xavier	Valencia – Black Mountain
CS1 – Three Points	

Table 19. 115kV Potential Projects

Saguaro – Naviska – Adonis – Thornydale – Camino de Manana – North Loop: This project represents the possible ultimate configuration for the SWTC 115kV line that is described as the 4th circuit on the Tortilita – North Loop Quad project.

All remaining 115kV Potential Projects: These projects are intended to improve 115kV system reliability by effectively integrating the CAP, SWTC and WESTERN systems.

Possible Interconnections	
North Loop – Rattlesnake Tap 345/115kV	Vail 345/230kV
SS 30 345/115kV	Del Bac 345 or 230/115kV
Hartt 345 or 230/115kV	Three Points/CS1 345/230/115kV

Table 20. Potential Interconnections Projects

North Loop – Rattlesnake Tap 345/115kV: This project would provide a new 345/115kV transformation at the North Loop substation. This would become a new source to the area SWTC/CAP/WESTERN system.

Vail 345/230kV: This project would add new 345/230kV transformation at the Vail substation to allow interconnecting the SWTC 230kV line(s) between Pantano and Sahuarita.

SS 30 345/115kV, Del Bac 345 or 230/115kV: This project would add a new 345/115kV transformation at the proposed SS 30 substation which is in the vicinity of the existing WESTERN Del Bac switching station. A new 115kV source could possibly introduce a

new connection to the SWTC/CAP/WESTERN 115kV systems.

Three Points/CS1 345/230/115kV: This project would add a new source to supply the SWTC/CAP/WESTERN 115kV systems. It could also accommodate a new 345kV or 230kV line to the Bicknell substation.

Hartt 345 or 230/115kV: This project would represent a joint project among SWTC, TEP and Trico. The project is not necessarily to be constructed at the proposed location of TEP's load serving substation referred to as Hartt. Rather, the idea is to plan a joint project that meets the TEP and Trico load serving needs while improving EHV/230kV transmission network reliability.

17. WESTERN 115kV Transmission Corridor

The WESTERN 115kV transmission corridors within the SATS study area have been identified as valuable assets for a number of the alternative projects. A few 345kV projects have the potential for becoming viable assuming the ability to utilize the existing 115kV WESTERN transmission corridor from Saguaro through Marana Tap, continuing southeasterly into and through Tucson, terminating at South Loop. These WESTERN corridors and their potential utilization are shown below in Figure 17: WESTERN 115kV Corridors.

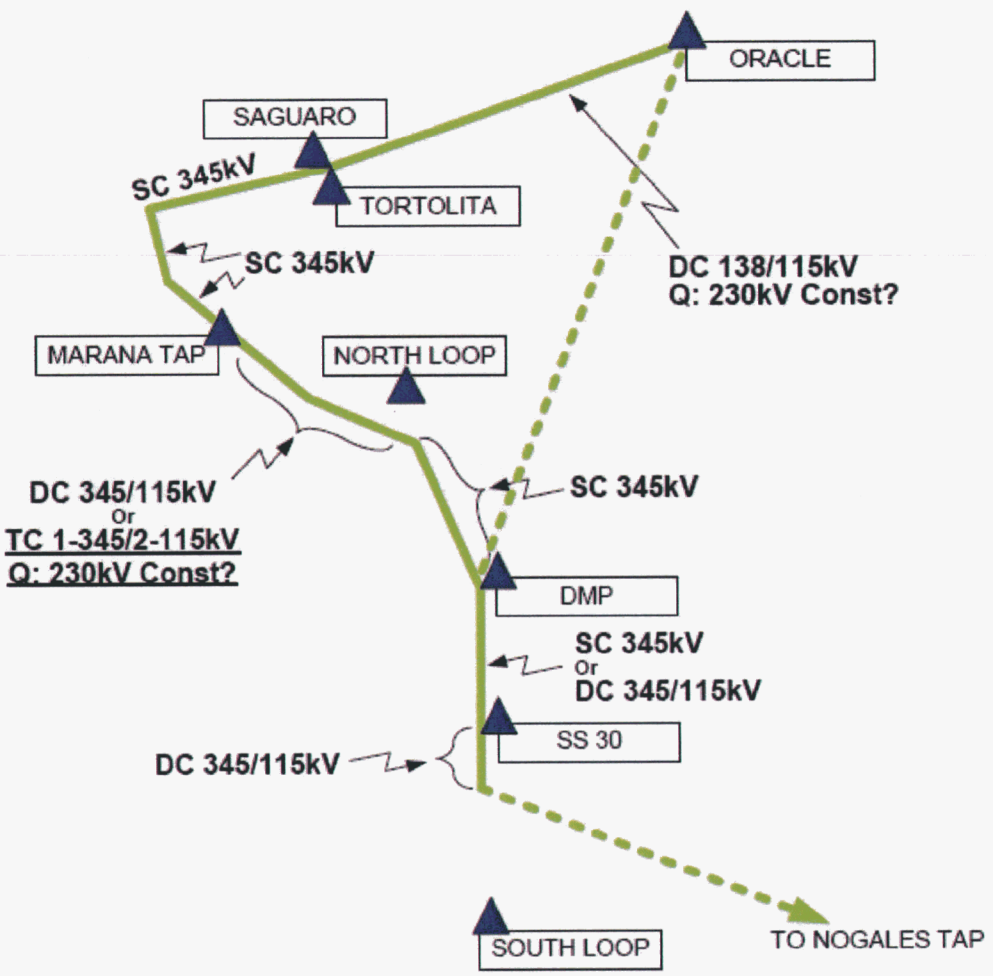


Figure 17. WESTERN 115kV Corridors

WESTERN was requested by the SATS participants to complete a study of its transmission corridor Right of Way (ROW) within the given study area south of APS'S Saguaro Substation as shown in Figure 17 above.

WESTERN's transmission corridor ROW study was broken down into three transmission line segments: 1. Saguaro Substation to Tucson Substation, 2. Saguaro

Substation to Oracle Substation to Tucson Substation, 3. Tucson Substation to Apache Substation.

17.1. Saguaro Substation to Tucson Substation:

ROW width: 100 FT
ROW restrictions: There is no voltage or construction restrictions as long as the new construction fits within the existing ROW width and the transmission poles are owned by the Federal Government.

17.2. Saguaro Substation to Oracle Substation to Tucson Substation:

ROW width: Corridor width is still under investigation
ROW restrictions:
a. There are no voltage or construction restrictions as long as the new construction fits within the existing ROW width and the transmission poles are owned by the Federal Government.
b. A portion of the given line is already double circuited with another utility between Oracle Substation and Tucson Substation.

17.3. Tucson Substation to Apache Substation:

ROW width: Corridor width is basically 100 FT with the exception just outside of Tucson Substation which WESTERN is reviewing to be sure the information provided on the ROW spreadsheets as provided to the SATS group is accurate.

ROW restrictions: There are no voltage or construction restrictions as long as the new construction fits within the existing ROW width and the transmission poles are owned by the Federal Government.

17.4. General Comments:

Any corridor width adjustments would require WESTERN to go back to the land owner and renegotiate a new ROW easement agreement. If

renegotiations with the perspective land owner are not successful, as a last resort the Federal Government can use its condemnation rights to obtain the necessary corridor.

There are mutual benefits to be gained by joint planning for transmission assets in these corridors. SATS participants may benefit through the ability to site high voltage transmission facilities, while WESTERN may benefit from improved reliability and load serving capability. All could be potentially more cost effective than each planning and developing their respective systems individually.

18. Southwest Public Power Resource (SPPR) "Three Terminal Plan"

The Southwest Public Power Resource (SPPR) group investigated a "Three Terminal Plan", shown in Figure 18 below, to develop and transmit power from proposed new generating resources in Pinal County while the SATS study was in process. This plan envisions three 230kV lines interconnecting the new generator to three transmission system points of interconnection, one of which would be the SWTC Marana Tap 115kV substation. The proposal calls for the existing WESTERN 115kV line from just west of the APS Saguaro station to Marana Tap to be replaced with a new double circuit 230kV constructed transmission line. One of the circuits would be operated at 115kV to restore the existing WESTERN 115kV topology. The other would serve as the 230kV path from the new generator to the Marana point of interconnection through a 230/115kV transformer.

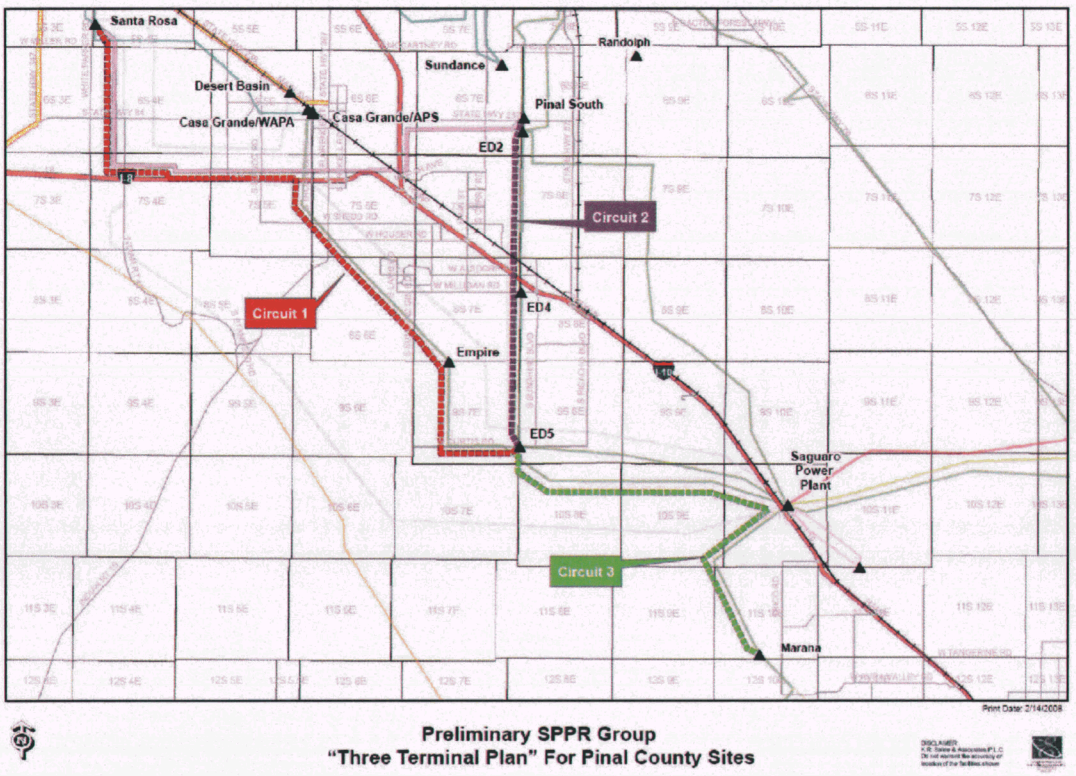


Figure 18. Preliminary SPPR Three Terminal Plan

The possibility of this new 230kV source at Marana presents an alternative that had not been previously explored. Therefore a "Task Force to analyze the common facilities within the individual plans and develop a joint plan for these common facilities" has been formed.

The status of this task force effort, along with the plan and schedule to complete the study is included in Appendix E to this report.

19. Long-Term SATS and Individual EHV Transmission Provider Strategies

Strategies were created by assembling appropriate combinations of the Projects listed in Section 16. Alternative Projects. The study scope calls for strategy designs to be based upon the "NW & SE Resources" scenario first, to be followed, in subsequent phases of this study, by sensitivity analysis to the "Balanced Resources" and "Internal Generation" scenarios. This sensitivity analysis may entail reducing imports from the northwest and southeast to accommodate imports up to 1,000 MW from south of

Tucson and/or south of Cochise County. The objective is to identify changes to the transmission configuration resulting from the shift in location of imports into the SATS area.

The SATS group investigated the projects listed in Section 16. Alternative Projects, and determined which of the EHV projects, based on N-1 analysis, are most likely to meet the objective of effectively delivering power from the SATS interface to the load centers within SATS.

Six EHV strategies were developed, each with the intention to supply the TEP and Trico systems assuming build-out in the Tucson area. Two of the options, that were intentionally very different from each other, were initially given high priority to be evaluated. However, options that minimize EHV construction through highly developed areas were subsequently assigned the highest priority due to their favorable technical, economic and aesthetic characteristics. Therefore analysis of a robust alternative that would entail constructing two new 345kV transmission lines through the City of Tucson and the surrounding densely populated area (Strategy A) was minimized. More concentrated effort was then directed toward alternatives that extend 345kV transmission from the existing EHV interconnections into the Tucson load center (Strategies C and F). All EHV strategies are described and shown graphically in this section.

The idea behind choosing strategies that are significantly different from each other was to make sure that all bases were covered considering long range uncertainty, of which load growth uncertainty is among the greatest of concerns. Hence the most robust option (Strategy A) was evaluated first to determine its ability to serve load reliably at saturation. Given the environmental, aesthetic and cost concerns associated with Strategy A, alternatives with lower impacts were developed and they also demonstrated the ability to supply load at saturation. While no analysis was done beyond the saturated load level, Strategy A appears to have the ability to serve loads greater than the amount that was projected at build-out based on existing land use plans. Therefore other strategies were selected in part based on the potential to transition to the Strategy A topology if loads greater than saturation appear to be imminent. In other words the relative merits of each alternative could help attain the objective of plan flexibility. Plan flexibility is examined in Section 25: Developing a Flexible Plan. As the analysis

progressed, a new strategy emerged and the study focus shifted to it. The new alternative, Strategy F, which effectively replaces SS NO30 with a similar facility at the Irvington location, and eliminates the Vail to East Loop 345kV and the East Loop 345kV yard, was viewed as a significant improvement over Strategy C.

The most salient difference between Strategy A and Strategies C or F is elimination of 345kV lines passing through Tucson. The other difference is that slightly more 138kV system reinforcement may be required in Strategies C or F because the EHV lines in Strategy C may reduce transfer across the 138kV under contingencies. Study effort was concentrated on Strategies C or F. Therefore no analysis was done to ascertain the difference in 138kV infrastructure between Strategy A and Strategies C and F. Note that, whether or not power transfer across Tucson occurs depends more on where new generation and/or mega-projects interconnect than the differences between strategies. More detail on strategies is included in this section.

Each of the strategies, at the saturated load level, examined new 500kV facilities interconnecting the Winchester and Pinal West substations, to include 500/345kV interconnections at the Vail and South Loop substations. The Winchester-to-Vail segment included two 500kV lines. Preliminary analysis indicates that 500kV will not be needed to serve SATS at the 20-year load level. Justification for investment in 500kV facilities will require further evaluation considering anticipated load growth rate, the potential for sponsors, possible mega-project interconnection requests, and other business factors. The decision on the choice of 345kV versus 500kV construction is on the project critical path since EHV additions in that corridor will likely be needed within the 5- to 10-year timeframe.

19.1. **Project Assumptions**

All strategies, at the saturated load level, assumed new 345kV lines from Tortolita to Marana Tap to Three Points with 345/115kV connections at Marana Tap and Three Points. They also assume a new 230kV Three Points to Bicknell line, which may be reconsidered at 345kV. Finally a 500kV Winchester to Tortolita line was common to all strategies. However, the need for these projects has not been confirmed. Studies of alternative configurations indicate that these projects may not be needed for SATS area load serving capability within the twenty year planning horizon. Therefore sensitivity studies removing these projects were done within the ten year planning horizon.

As the study progressed, an assessment of "Committed" and "Planned" projects was done in light of information that was not available at the time decisions were made to pursue them. Among others, the Pinal Central to Tortolita 500kV project, which was scheduled to be permitted, constructed and placed into service by 2011 prior to the beginning of the SATS study was reviewed considering the impact of projects that may interconnect southeast of Tucson. Recent information suggests that projects such as Bowie generation and SunZia may be put into service within the same five year time frame. Generally, these projects change the magnitude of power flows into the TEP EHV points of interconnection by a large margin. These projects therefore have the potential to influence the timing, and possibly the technical and economic viability of alternative EHV interconnections.

Table 21 demonstrates the impact of various projects interconnecting with the SATS system. For example, removal of the two-circuit 345kV Tortolita to North Loop project reduces flow entering at Tortolita and accordingly increases flow through the Vail and South Loop delivery points. Connecting the 500 MW Bowie generating station at the proposed Willow 345kV point of interconnection further reduces flow through Tortolita. Adding 500 MW of generation at the Winchester 500kV station, in addition to Bowie, simulating a SunZia interconnection at a relatively low power output effectively substitutes Vail for Tortolita as the strongest source. The purpose of this table is only to demonstrate the heavy influence that major projects such as Bowie generation and SunZia have on power flows into the TEP system in Tucson. There was no attempt to optimize transmission system design for both of these new facilities. This scenario analysis was done simply to gain a better understanding of the benefits and impacts of these proposed projects.

10 Year Horizon	Tortolita		Vail		South		Hartt		Total Import
New EHV Project	MW	%	MW	%	MW	%	MW	%	MW
PC – TO 500kV & 2 TO – NL 345kV	1354	46	945	32	428	15	209	7	2936
PC – TO 500kV	1209	41	1017	35	482	15	215	7	2923
Bowie 500 MW	1098	37	1136	38	498	17	228	8	2960
Bowie & SunZia	1014	34	1218	41	518	17	242	8	2992

Table 21. Flow Impacts of Major EHV Projects on TEP System

Large impacts caused by such projects interconnecting to the TEP EHV network presents a significant planning challenge. Emerging information indicates that the likelihood of Bowie and SunZia being in service by 2011 and 2013 respectively has recently increased by a significant margin. Nevertheless, these projects continue to be treated as uncertainties since none are firmly committed as of this time. As a result, prior analysis which assumed the Pinal Central to Tortolita 500kV project to be in service in 2011, with little likelihood of Bowie and SunZia interconnecting within the same time frame, favored the North Loop 345kV injection proposal as the next EHV upgrade. Therefore all prior analysis had to be repeated with SunZia and Bowie interconnected. The results indicate that a Tortolita to North Loop 345kV project may be deferred, and a 345kV project at either SS NO30 or Irvington could be considered more feasible as the next major EHV upgrade. More analysis will be required within the five to ten year planning horizon to optimize system investments considering the uncertainty associated with these projects. Since neither of the Bowie or SunZia projects is absolutely committed at the time of this writing, the possibility of multiple outcomes must be evaluated.

Following is a description and discussion of Strategies A through F:

19.2. Strategy A

Strategy A, shown in Figure 19. TEP EHV Strategy A envisions the addition of two new 345kV lines effectively going through the Tucson metropolitan area with three new 345/138kV interconnections to the local area 138kV network. One 345kV line would begin at Tortolita, extend to North Loop continue to East Loop and terminate at Vail,

with two new 345/138kV interconnections at North Loop and East Loop. The second 345kV would begin at Tortolita, follow the WESTERN 115kV right-of-way to the SWTC Marana Tap, continue along the WESTERN ROW into Tucson to a new 345/138kV substation (SS30) and terminate at South Loop. The WESTERN 115kV corridor would be utilized to minimize impact cost, environmental and aesthetic impact. A disadvantage however, is that the 100 foot right-of-way is less than TEP's existing standard as required for 345kV construction. Note that justification for investigating two 345kV lines along separate corridors was based on the assumption that they would be pursued jointly by SWTC, TEP and possibly other parties.

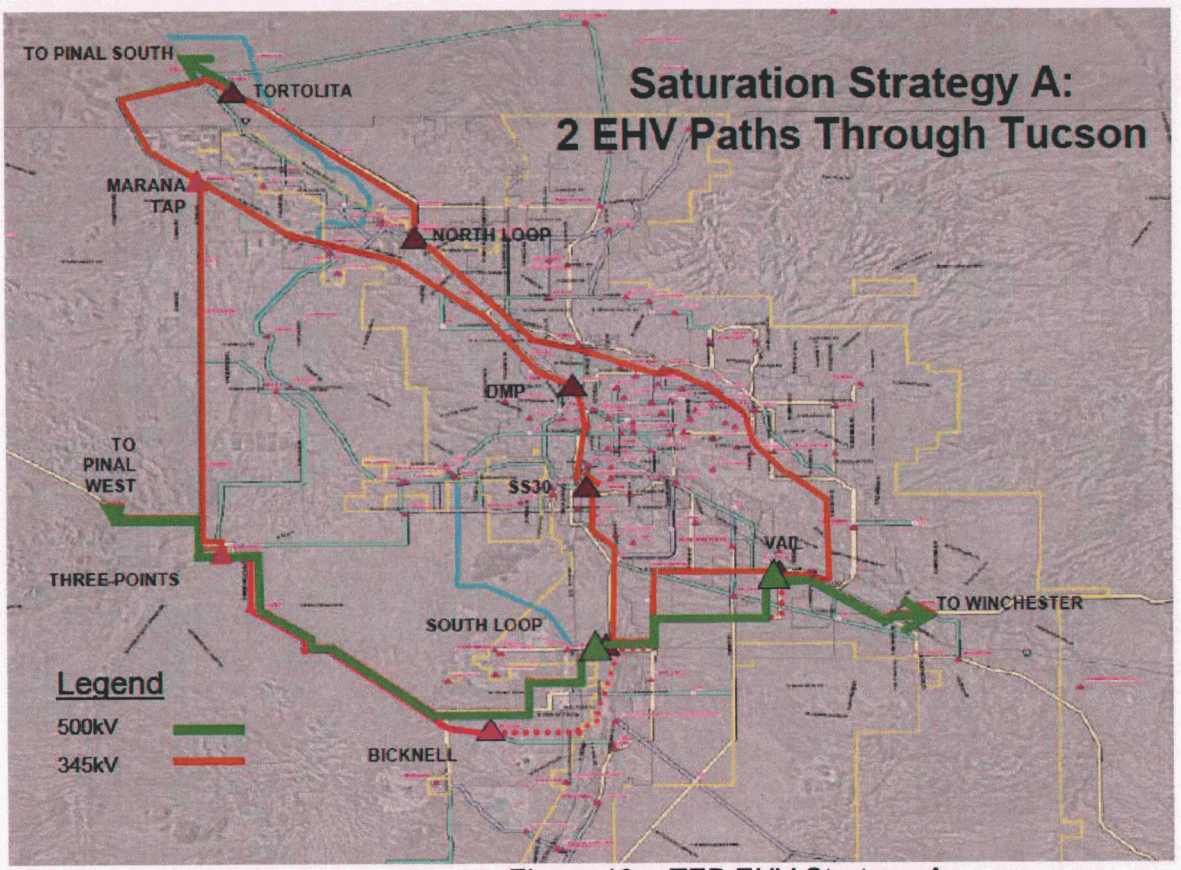


Figure 19. TEP EHV Strategy A

Strategy A is the most robust among the five alternatives. It has the potential for the greatest load serving capability, with the highest probability to serve loads in excess of the saturated load level. It envisions the largest amount of new 345kV construction

(~110 Miles), much of which passes through the relatively densely populated Tucson area. Therefore Strategy A involves the highest EHV capital investment and potentially has the greatest associated aesthetic and environmental issues.

19.3. **Strategy B**

Strategy B was developed with the intention of minimizing the number of new transmission lines needed through Tucson, and to minimize impact by utilizing the WESTERN 115kV corridor. However, as in Strategy A, the 100 foot right-of-way is less than TEP's existing standard as required for 345kV construction.

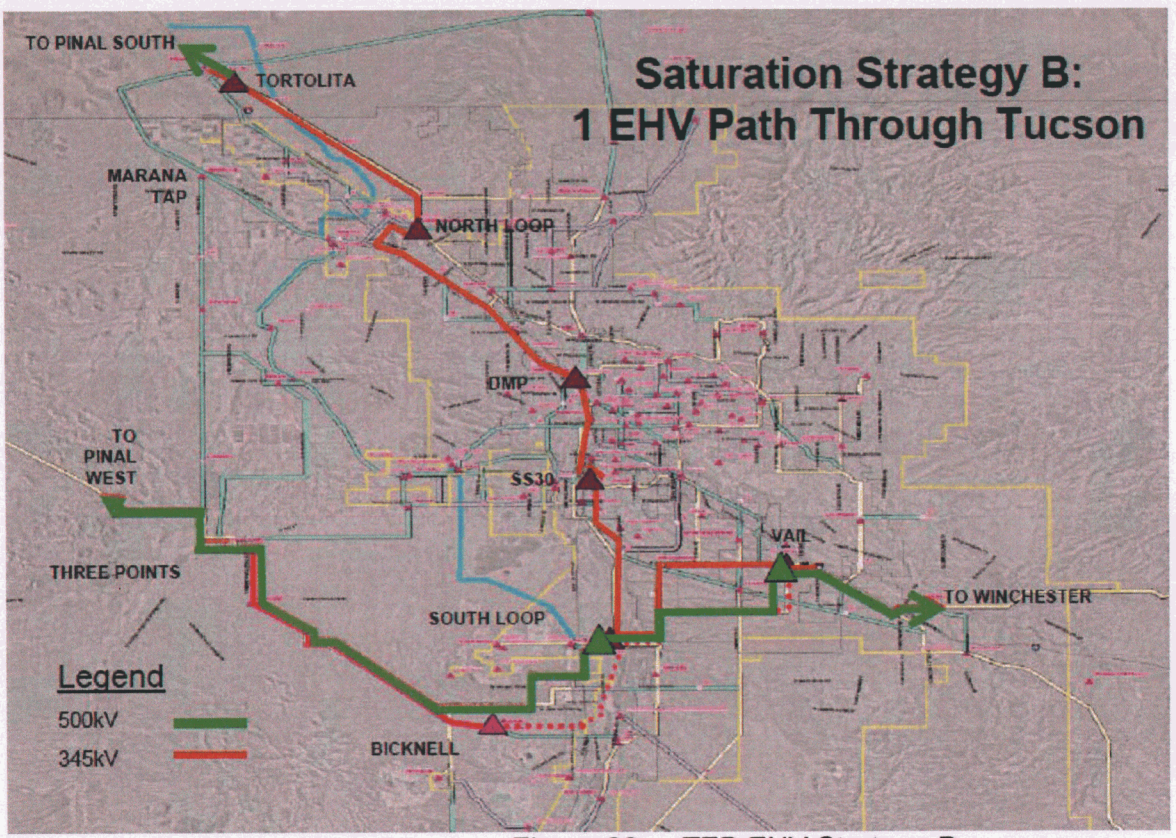


Figure 20. TEP EHV Strategy B

Strategy B EHV is less robust than Strategy A. It has the potential for somewhat less load serving capability, with lower probability to serve loads in excess of the saturation load level. It envisions a more moderate amount of new 345kV construction, with one new 345kV line passing through the relatively densely populated Tucson area. Strategy B intuitively requires a lower EHV capital investment than Strategy A. Its associated

aesthetic and environmental impact could also be significantly lower because most of the new 345kV construction would occupy the existing WESTERN 115kV corridor. However, the relatively narrow WESTERN corridor poses challenges in those segments where double circuit construction would be necessary. The other alternative in those segments would be to secure additional right-of-way, which would increase cost and require regulatory approval.

Strategy B envisions three new 345/138kV delivery points, all of which would be on the western side of Tucson. There would be approximately 60 miles of new 345kV lines, with some segments requiring double circuit.

Construction of local 138kV facilities required for Strategy B is expected to be somewhat greater than for Strategy A. No analysis was done to determine precise differences in 138kV design attributed to each of the EHV strategies.

19.4. **Strategy C**

Strategy C, also referred to as "Reach-In", entails construction of two new 345kV lines to the North Loop Substation, two new 345kV lines to the new SS30 from South Loop and Vail respectively, plus a new radial 345kV line from Vail to East Loop. Thus Strategy C includes the same new 345/138kV injection points as Strategy A. Also, similar to Strategy A, justification for investigating two 345kV lines along separate corridors was based on the assumption that they would be pursued jointly by SWTC, TEP and possible other parties.

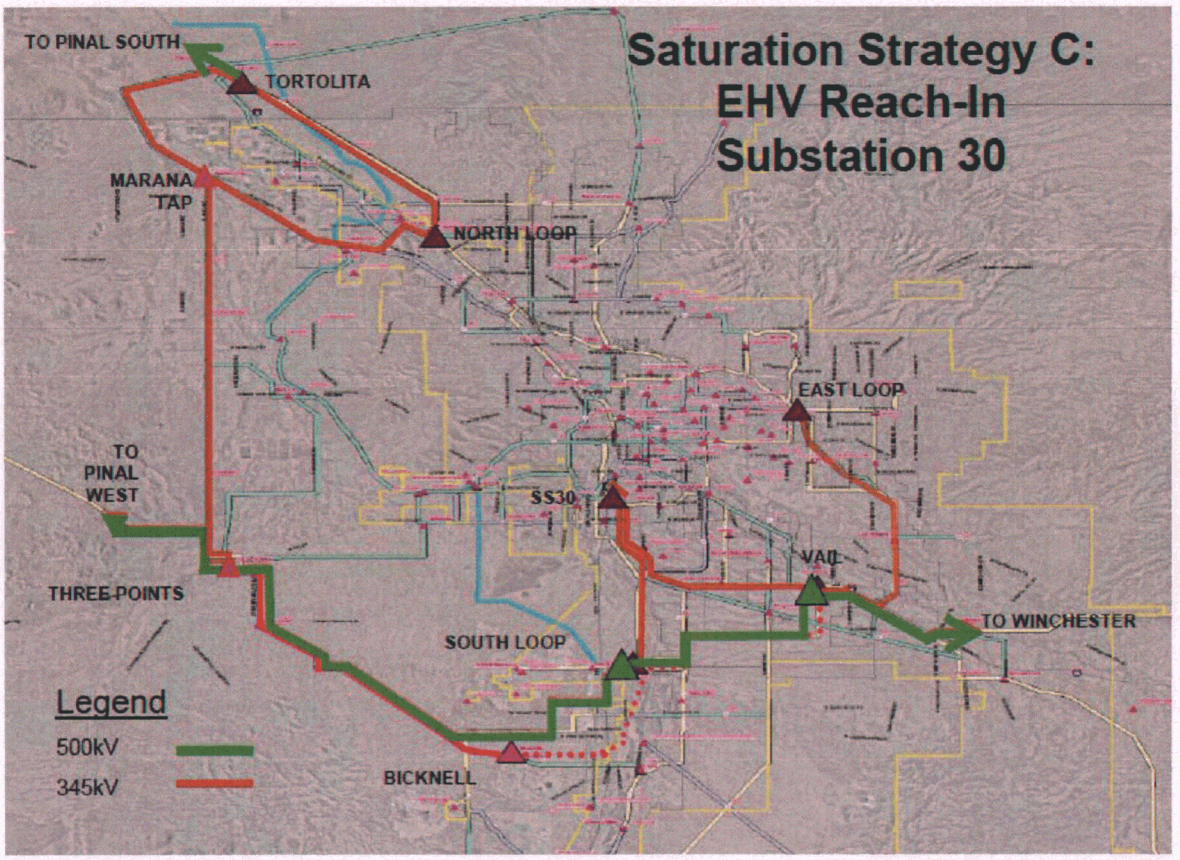


Figure 21. TEP EHV Strategy C

Strategy C EHV is less robust than Strategy A. It has the potential for lower long-term load serving capability and potentially could have limitations requiring some reinforcement to serve loads in excess of the saturated load level. It envisions less new 345kV construction than Strategy A. New 345kV lines would pass through much less of the relatively densely populated Tucson area. Strategy C involves a lower EHV capital investment than Strategy A, but possibly slightly greater than B. Its associated aesthetic and environmental impact would clearly be lower than Strategy A, but closer to Strategy B. Much less of the new 345kV construction would occupy the WESTERN 115kV corridor. However, over 30 miles of new line could potentially be built in existing TEP corridors[19] that are presently or planned to be occupied by 138kV. Approximately 28

[19] The determination of actual corridors to be selected if Strategy C is pursued will require a detailed land and environmental assessment.

miles would be in WESTERN corridors. Therefore challenges will also exist in those segments where double circuit construction would be necessary.

Strategy C envisions the addition of three new 345/138kV delivery points in the same locations as Strategy A. Approximately 75 miles of new 345kV lines would be required.

19.5. **Strategy D**

Strategy D was developed to address possible right-of-way acquisition and permitting issues associated with the South Loop to SS30 345kV line proposed in Strategy C.

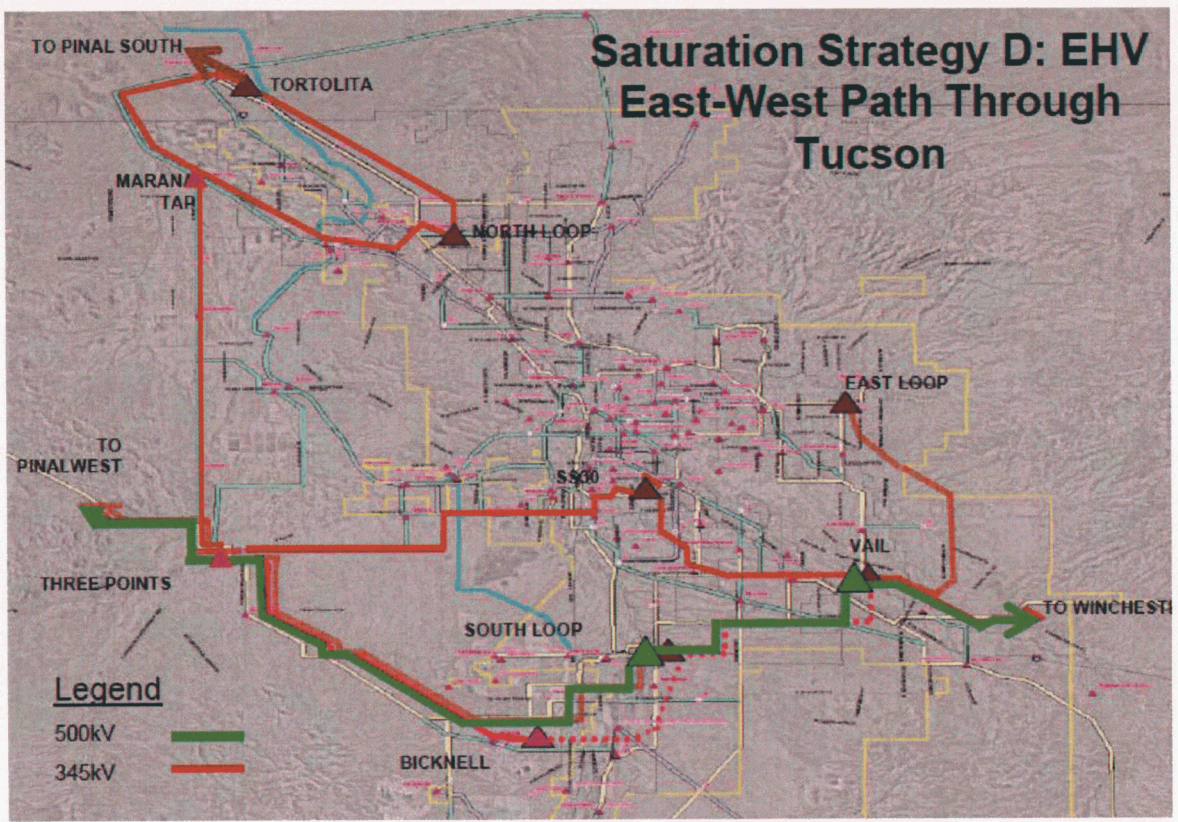


Figure 22. TEP EHV Strategy D

Thus, Strategy D functionally is anticipated to be very similar to Strategy C. The key difference is that the South Loop to SS30 345kV line is replaced by a Three Points to SS30 345kV line. However, there may be significant aesthetic issues in the Three Points to SS30 corridor. Evaluation of this option will be pursued if either Strategy C or F is found to not be feasible.

138kV system design is expected to be very similar, if not identical to that which would be associated with Strategy C.

19.6. **Strategy E**

Strategy E assumes no new 345kV construction from the current EHV delivery points into Tucson as shown in Figure 23.

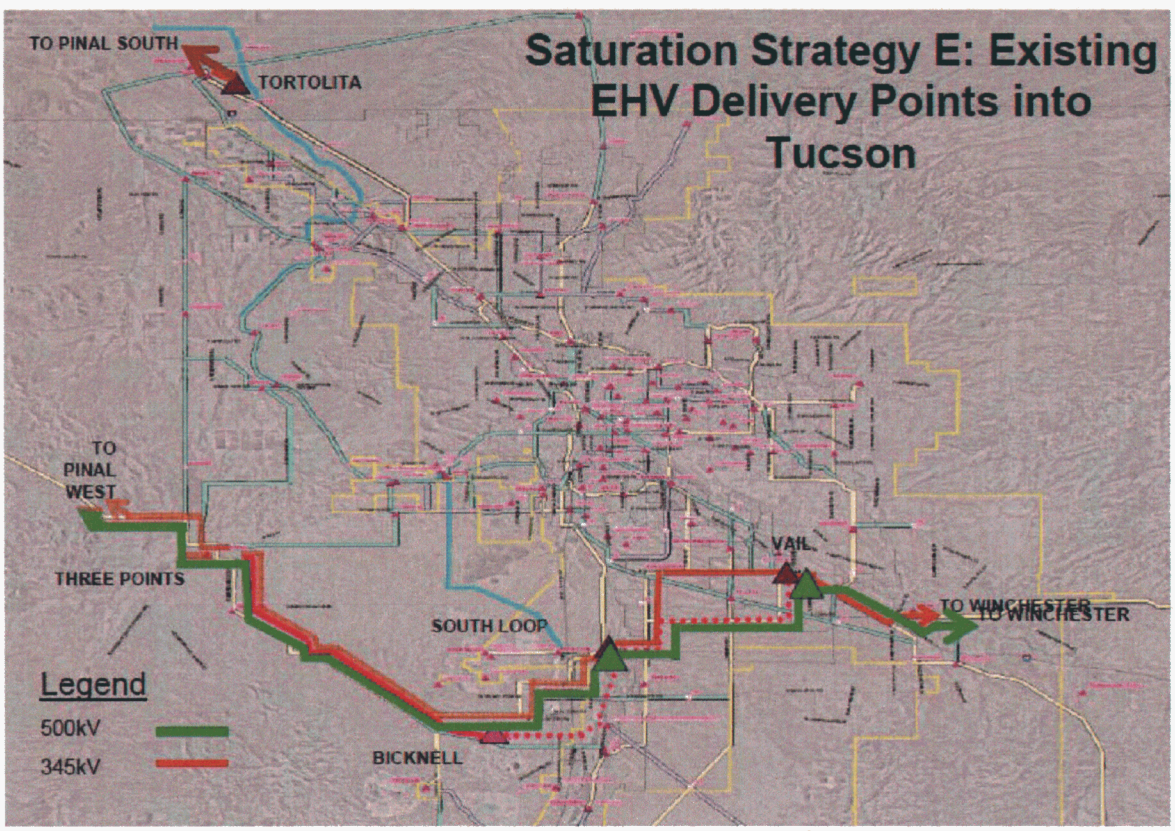


Figure 23. TEP EHV Strategy E

Substantially more 138kV construction would be required for Strategy E than any other option. Analysis done to date on Strategy C suggests that an option without EHV system reinforcement is not technically feasible. No detailed 138kV design was done for Strategy E.

19.7. **Strategy F**

Strategy F, shown in Figure 24. TEP EHV Strategy F, is a variation of Strategy C,

wherein SS30 would be replaced by a 345/138kV substation at Irvington with 345kV lines connecting it to the Vail and South Loop stations. Also, the radial line from Vail to East Loop and the East Loop 345kv station would be eliminated.

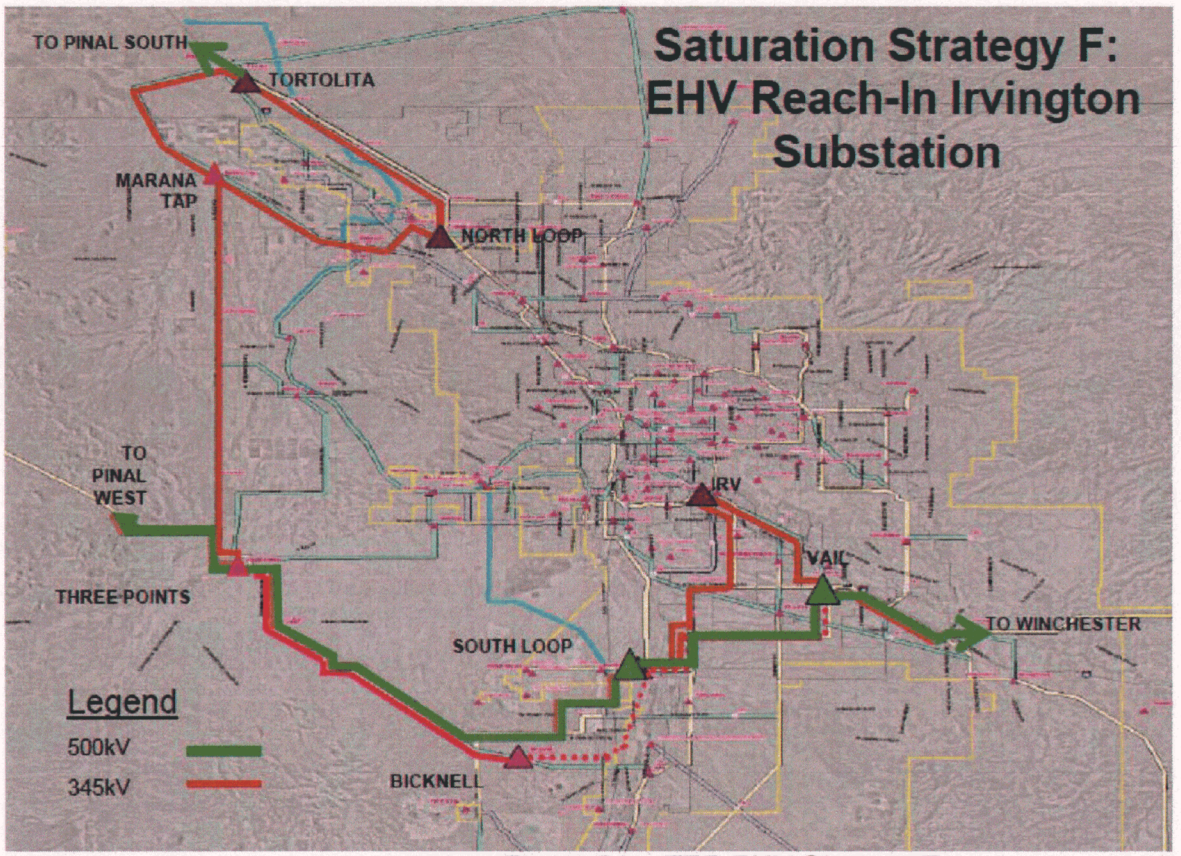


Figure 24. TEP EHV Strategy E

Strategy F Incorporates the two 345kV lines from Tortolita to North Loop and the new North Loop substation shown in Strategy C. It differs from Strategy C in that Irvington is the only new 345kV substation needed with new 345kV connections from Irvington to Vail and South Loop. The East Loop 345kV substation and radial line to the Vail station are not anticipated to be needed due to the more central location of Irvington.

138kV system design generally envisions rebuilding or reconductoring existing multiple circuits between the EHV delivery points and the load centers within Tucson. TEP 138kV system plans are described in Section 20. TEP 138kV Future System Strategy.

20. TEP 138kV Future System Strategy

As the study evolved, Strategy F was emphasized as the basis on which the TEP 138kV system would be designed. During the course of the study it was learned that the transmission system in southeast Arizona generally does not experience "flow-through". This characteristic is a major factor that allows the "reach-in" EHV strategies (C or F) to provide adequate load serving capability within the SATS load pocket[20]. Therefore 138kV configuration alternatives for any of the "reach-in" strategies would be quite similar. TEP's planning approach is to reinforce the Tucson area 138kV network by upgrading existing lines and in some cases adding new lines, thereby increasing transfer capacity into the load center from existing EHV delivery points. This tactic helps to defer the need for extension of new EHV into Tucson for as long as possible.

Several alternative 138kV configurations were postulated for the saturated load level, then reduced to the twenty year planning horizon and then to the 2018 load level. The following series of single line diagrams show the alternatives that were considered with the 2018 prominently displayed while facilities contemplated for later years are subdued.

Figure 25. TEP Transmission Location Reference is a master diagram which identifies where the subsequent single line representations are geographically located. Note that there are several 138kV alternative configurations for each of the areas shown.

The single line diagrams following the master diagram show alternative 138kV configurations within each of the defined areas shown on the master. These alternative projects were screened through a combination of judgment; land use, environmental and perceived cost considerations; and power flow modeling results. The result of this process is the 2018 project list.

[20] The phenomena of "no flow-through" is apparently due to the characteristics of the bulk transmission system with interconnected generation and load centers covering the southwestern portion of the Western Interconnection. Major new project interconnections could conceivably change the balance, potentially causing flow-through. SATS participants should consider this possibility in future system impact studies.

Options to defer all projects in this study will be continuously under investigation. The objective of the longer range study work is to identify system issues and determine alternatives that will likely be the ultimate solution. This provides an opportunity to address long lead-time activities such as right-of-way acquisition, permitting and so on.

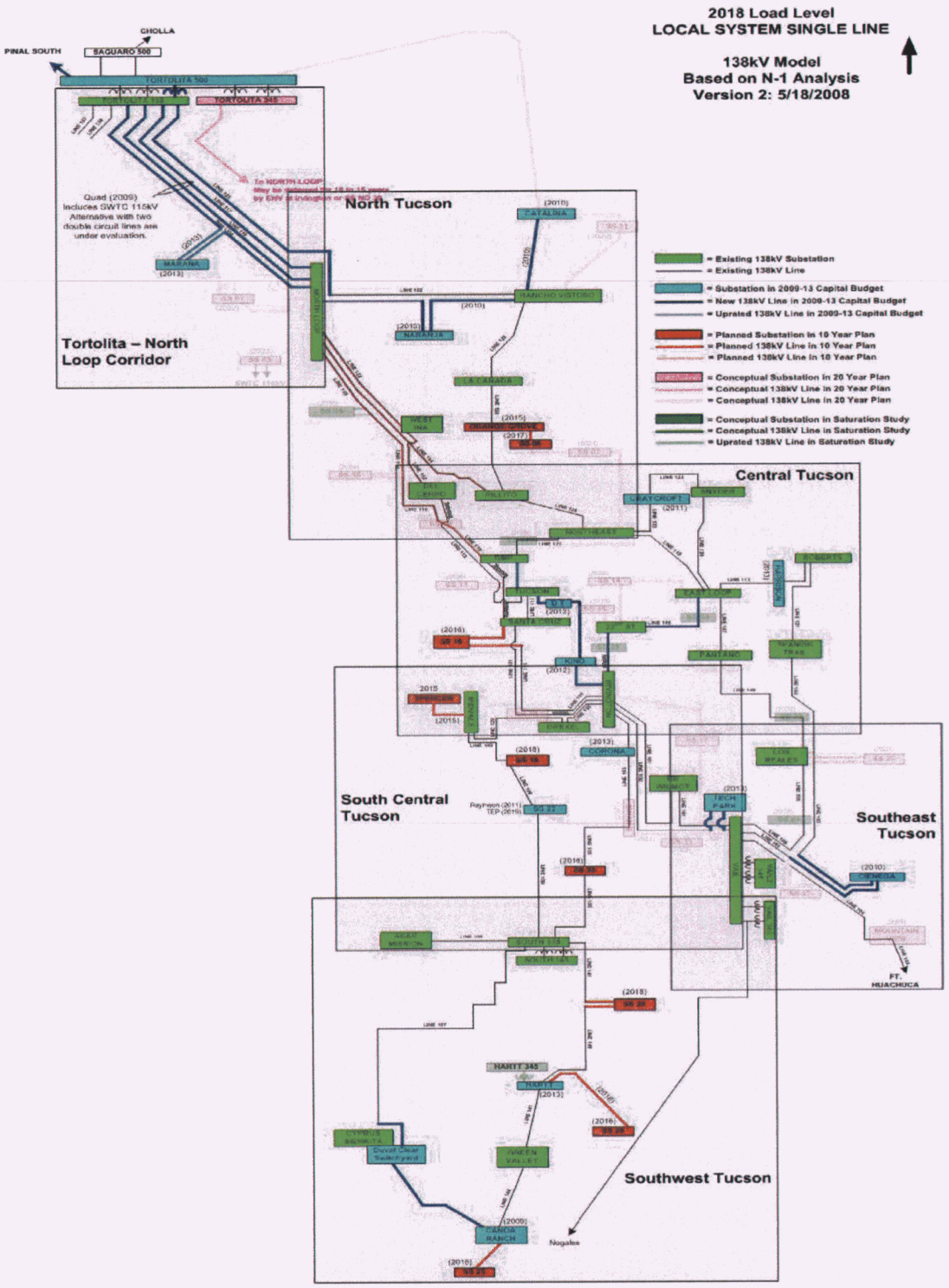


Figure 25. TEP 138kV Transmission Location Reference

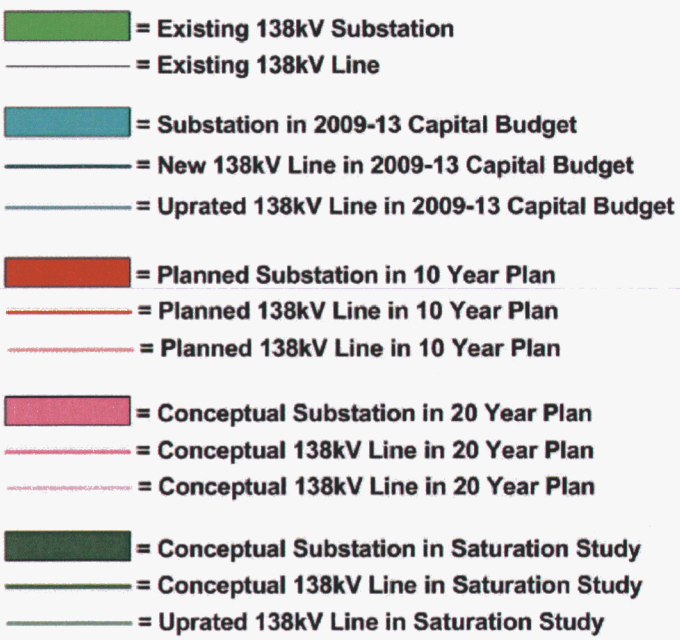


Figure 26. Legend for 138kV Alternative Projects Single Line Diagrams

The following descriptions help to provide a basis for the five and ten year planning effort, leading to well thought out five year capital budget and ten year transmission plans. Among the insights gained through the SATS study is the conclusion that increasing the capacity of existing 138kV transmission facilities from the three existing EHV delivery points (Tortolita, Vail and South Loop) should be a high priority. The TEP five year capital budget and ten year plan therefore will recommend staged reconductoring or uprate projects emanating from Tortolita, Vail and South Loop.

Referring to the Legend in Figure 26, each of the figures describing the following alternative 138kV projects shows those designated as "Existing", "2009-13 Capital Budget" and "Planned in 10 Year Plan" in normal type. Those designated "Conceptual in the "20 Year Plan" and "Saturation Study" as shown subdued. This helps to visualize ten year planning horizon projects in the context of potential ultimate build-out.

Tortolita – North Loop Corridor: The bulk of the work, shown in Figure 27, in the Tortolita – North Loop corridor is expected to be completed by 2010. The main project consists of three TEP 138kV circuits and one SWTC 115kV circuit on new "Quad" structures. The existing Line 125 will also terminate at the North Loop substation in 2010. Future plans, possibly beyond ten years, are for Line 125 to terminate at the Rancho Vistoso substation, when a related project results in a new connection between North Loop and Rancho Vistoso through a new Naranja substation. Refer to description under North Tucson – Option 1 and 2. Also note that actual project in-service dates may be changed during the five year capital budget development process. For example, the in-service date for the Marana substation and the tap to the new line may be delayed to 2014 based on local development data that became available after the SATS analysis was completed.

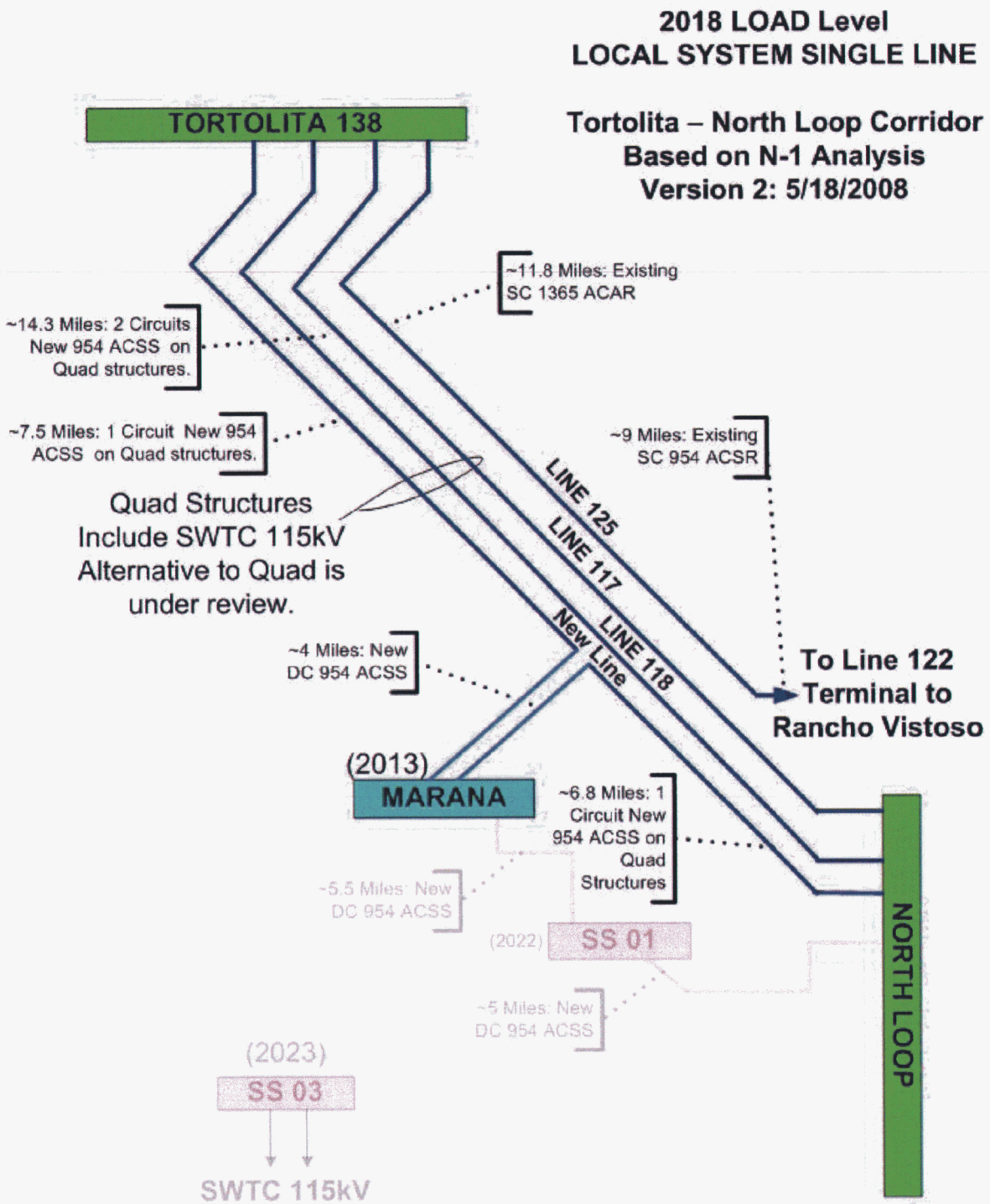


Figure 27. Tortolita – North Loop 138kV Corridor

North Tucson – Option 1 and Option 2: The Naranja substation is under investigation in either of the North Tucson options for the post-five year capital budget time frame. The current plan for 2010 indicates there will only be one 138kV line from North Loop to Rancho Vistoso. Staging evolution of upgrades in the Tortolita – North Loop Corridor such that a connection from Tortolita to Rancho Vistoso is deferred, also defers line upgrades from Rancho Vistoso to La Canada. Moreover, this allows the Naranja substation to be delayed until it is needed to serve local distribution load. The Naranja substation would otherwise have to be advanced to free up an existing 46kV line that is insulated for 138kV to allow the configuration shown in Figures 28 and 29.

The key feature of North Tucson – Option 1 is that the 138kV lines running south out of the North Loop substation are envisioned to be reconductored using advanced high temperature conductor. The advantage of doing so is the ability to utilize the existing triple circuit structures and avoid permitting and relatively high cost associated with a new North Loop to Rillito 138kV line as shown in Figure 29. North Tucson – Option 2.

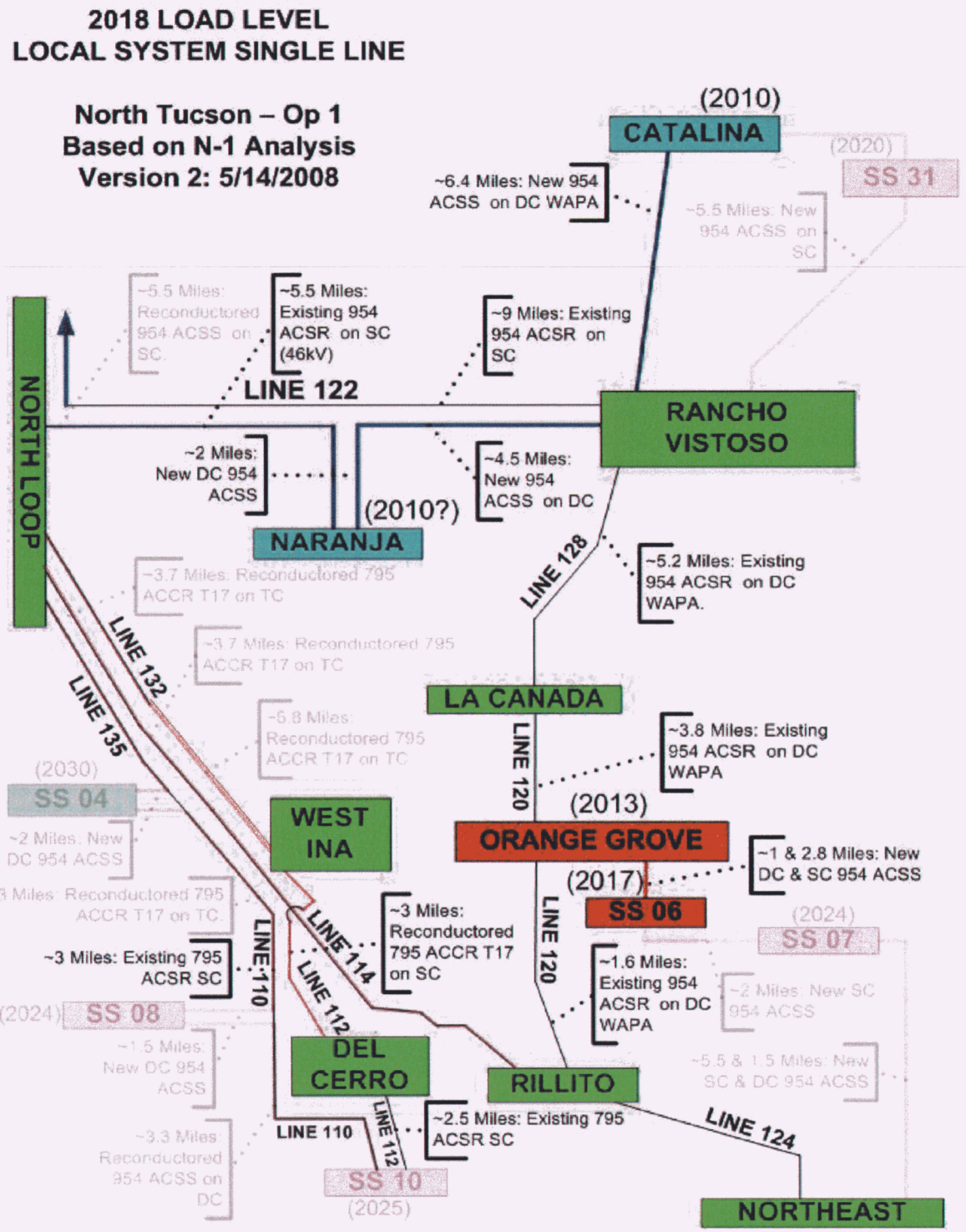


Figure 28. North Tucson – Option 1

A new 138kV line, such as North Loop to Rillito, that occupies a sensitive corridor could preclude the ability to site, permit and construct a future EHV line as envisioned in Strategy A. Thus a critical component needed for long term planning flexibility would be lost. In other words, reconductoring helps to maintain planning flexibility by minimizing construction of new facilities in a critical corridor, thereby improving the likelihood of siting a new EHV line in the event higher than anticipated load growth materializes in the future.

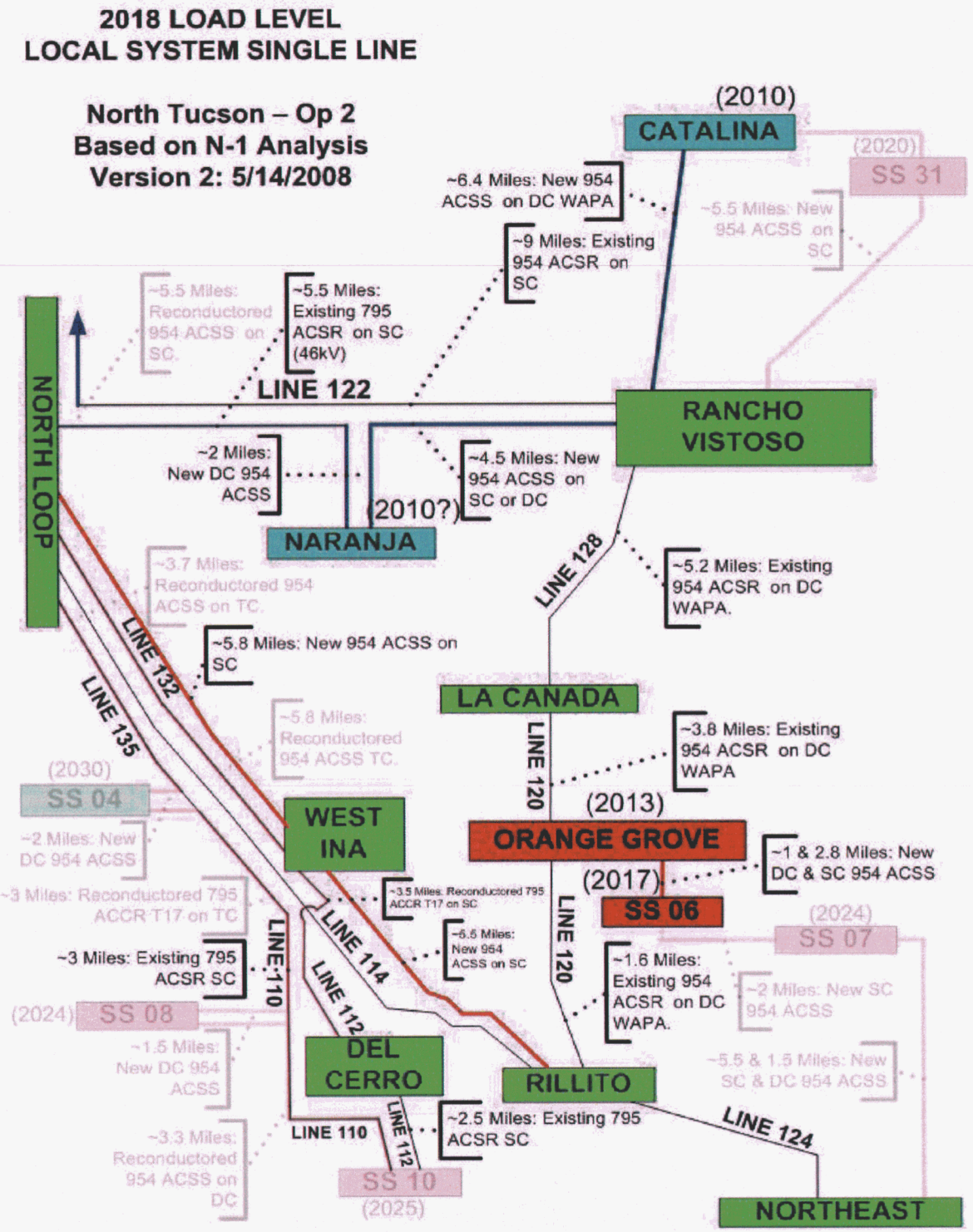


Figure 29. North Tucson – Option 2

Other long term considerations, such as the potential for load growth in areas where there is no existing transmission infrastructure should be taken into account. For instance, SS 06 and SS 07 could ultimately be served by a new 138kV line interconnecting the Orange Grove and Northeast substations. This new line would provide system benefits by introducing a parallel path between Rillito and Northeast. The value of this line would have to be weighed against the associated permitting effort and total cost. In either case, it makes sense to pursue a new line to serve SS 06 within the ten year planning horizon, and eventually SS 07 assuming development actually occurs in that area.

Central Tucson Area – Option 1 Through Option 5: The following five options consist of alternative 138kV local transmission system configurations that take advantage of opportunities provided by having a reasonable sense of the number and relative location of potential new substations that would eventually be needed at build-out. The Central Tucson Area is critical as it makes up a large portion of TEP's load center which interfaces with the primary interconnections from Tortolita (through North Loop), and Vail.

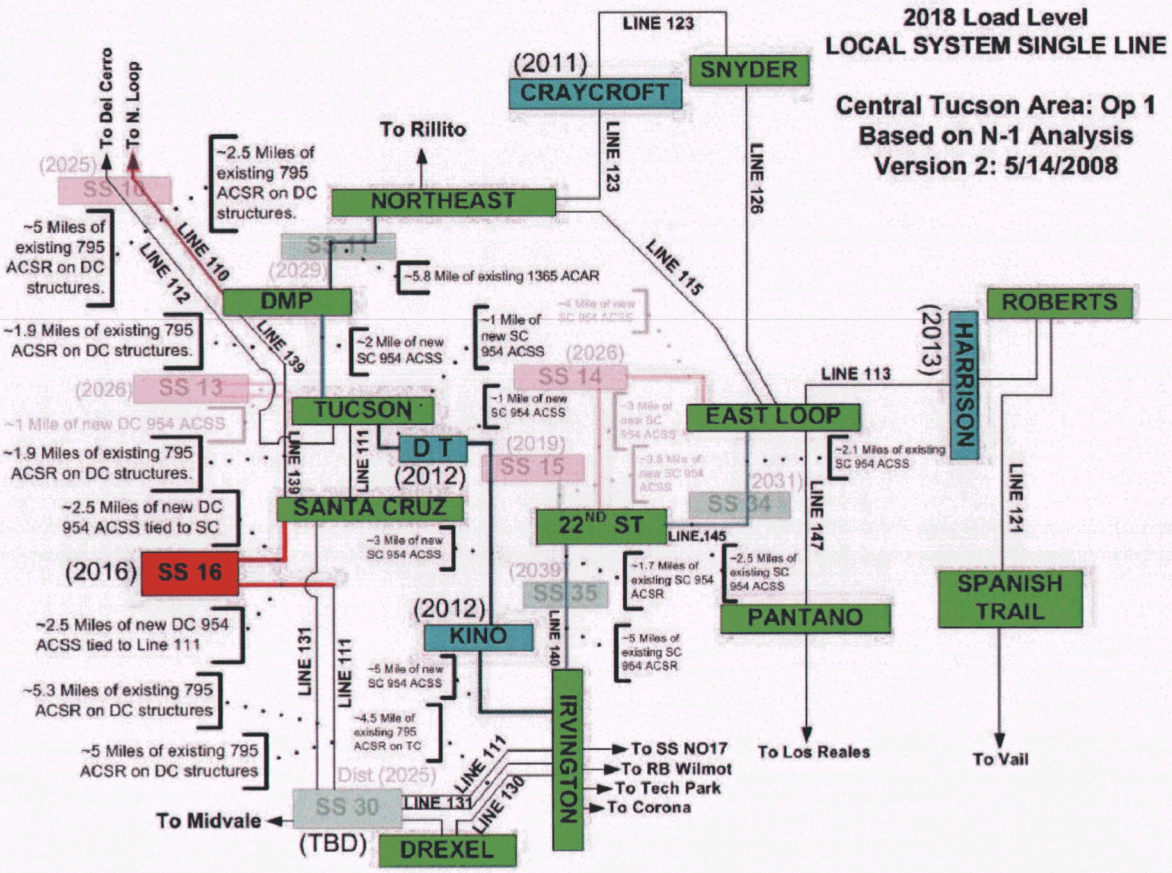


Figure 30. Central Tucson Area – Option 1

New lines, such as Irvington – Kino – D T (Downtown) – Tucson 138kV are shown in blue. This particular line shows up in all five options because it creates a new path from the strong source at Irvington into the load center. Part of the justification is that new substations may be supplied from this new line. Otherwise taps would have to be made to existing lines, which would in turn become more heavily loaded. Plus the cost of these taps could be contributed toward the new line. Therefore the new line provides multiple benefits by enhancing system transfer capacity as well as interconnecting new load serving substations.

Evaluation of the five Central Tucson Area options facilitated critical thinking and discussion among transmission and distribution system designers. For example, the proposal for the Downtown substation is being reconsidered in view of increasing

physical congestion as development becomes more concentrated in the business area of Tucson. The result is alternatives to eliminate the Downtown substation by expanding the Tucson substation using Gas Insulated Substation (GIS) technology and relocating and enlarging the proposed Kino substation are under investigation.

Uprate of the Irvington to Twenty Second Street to East Loop 139kV line was also common to all options. This project will consist of reconductoring with some structure rebuilding to increase the capacity needed to maintain reliable service to the portion of the TEP local area network east of the Davis-Monthan Air Force Base. This project will be addressed in the TEP five year capital budget. Longer term benefits of increasing the capacity of this line includes the ability to supply new load as shown by SS 34 and SS 35, when and if development occurs.

Additional facilities, looking at the twenty year planning horizon, would involve constructing new 138kV lines to integrate SS 14 and SS 15 as development continues just east of the downtown area. Options include opening new paths from Twenty Second Street to the Tucson substation (Options 1 – 5) and Twenty Second Street to the East Loop (Options 1, 4 and 5) or Northeast (Options 2 and 3) substations. All of these options strengthen and increase the 138kV system transfer capability needed to serve increasing load.

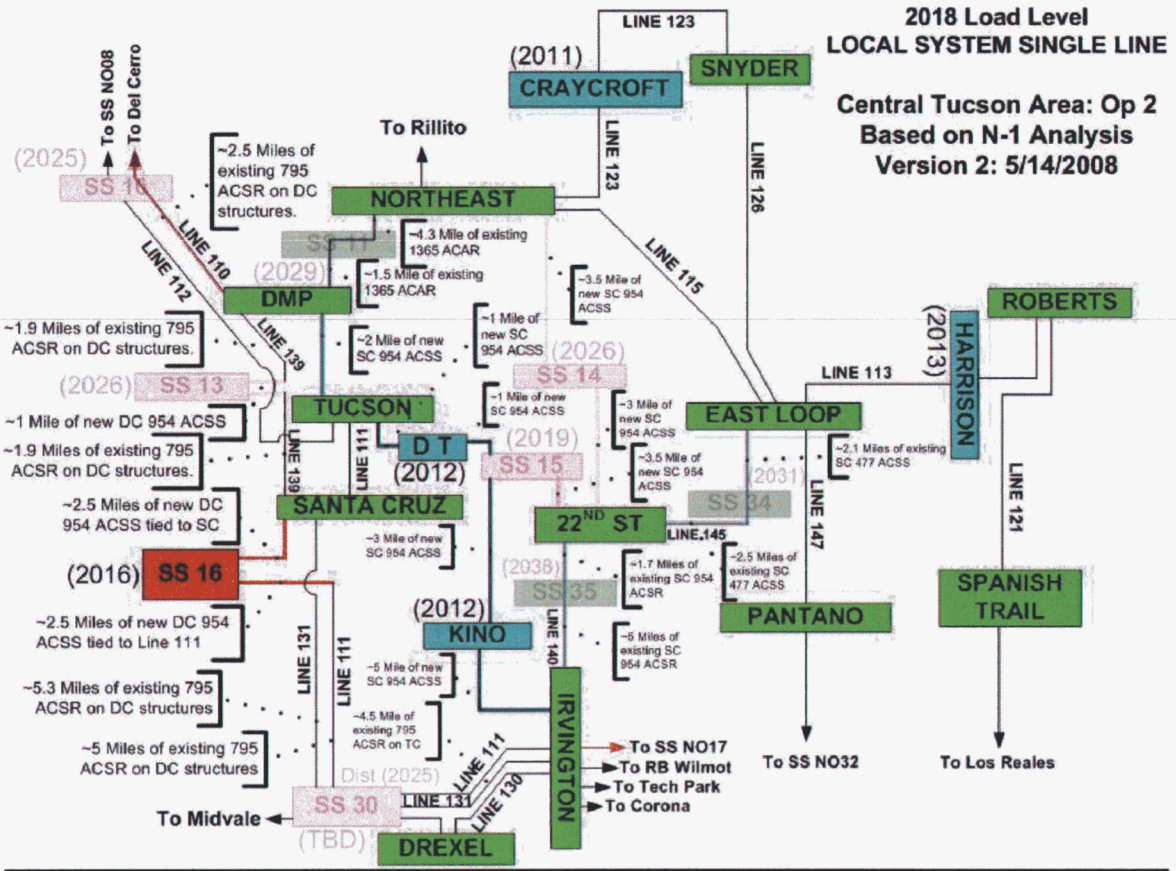


Figure 31. Central Tucson Area – Option 2

Anticipated economic development east of the Santa Cruz River would be met by the addition of new load serving substations including SS 16 within ten years, and SS 10 and SS 13 within twenty years. These substations would be sited relatively close to the WESTERN 115kV corridor. TEP's options for interconnecting these substations assumed the WESTERN corridor would be preserved for higher voltage transmission to maintain flexibility for the SATS planning area. Therefore, SS 16 and SS 13 were modeled as double circuit taps to existing TEP lines.

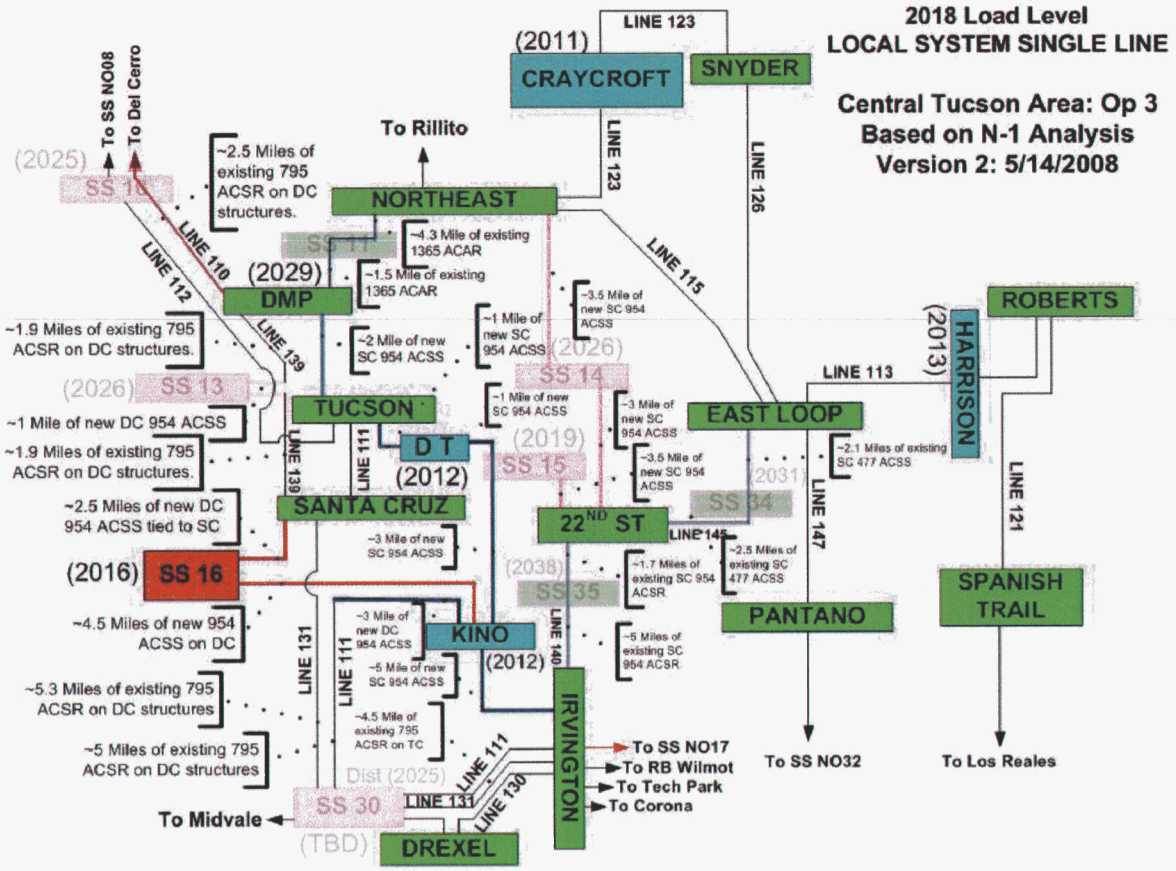


Figure 32. Central Tucson Area – Option 3

Alternatives to SS 16 tapping the Irvington to Santa Cruz line as in Options 1, 2 and 5 are shown in Options 3 and 4. The latter are less likely due to concerns over the ability to site east to west oriented lines extending from approximate location of the Kino substation. Hence the SS 16 interconnection configuration shown in Options 1 and 2 is preferred. Further analysis based on land and environmental considerations will be needed to make the decision regarding SS 16.

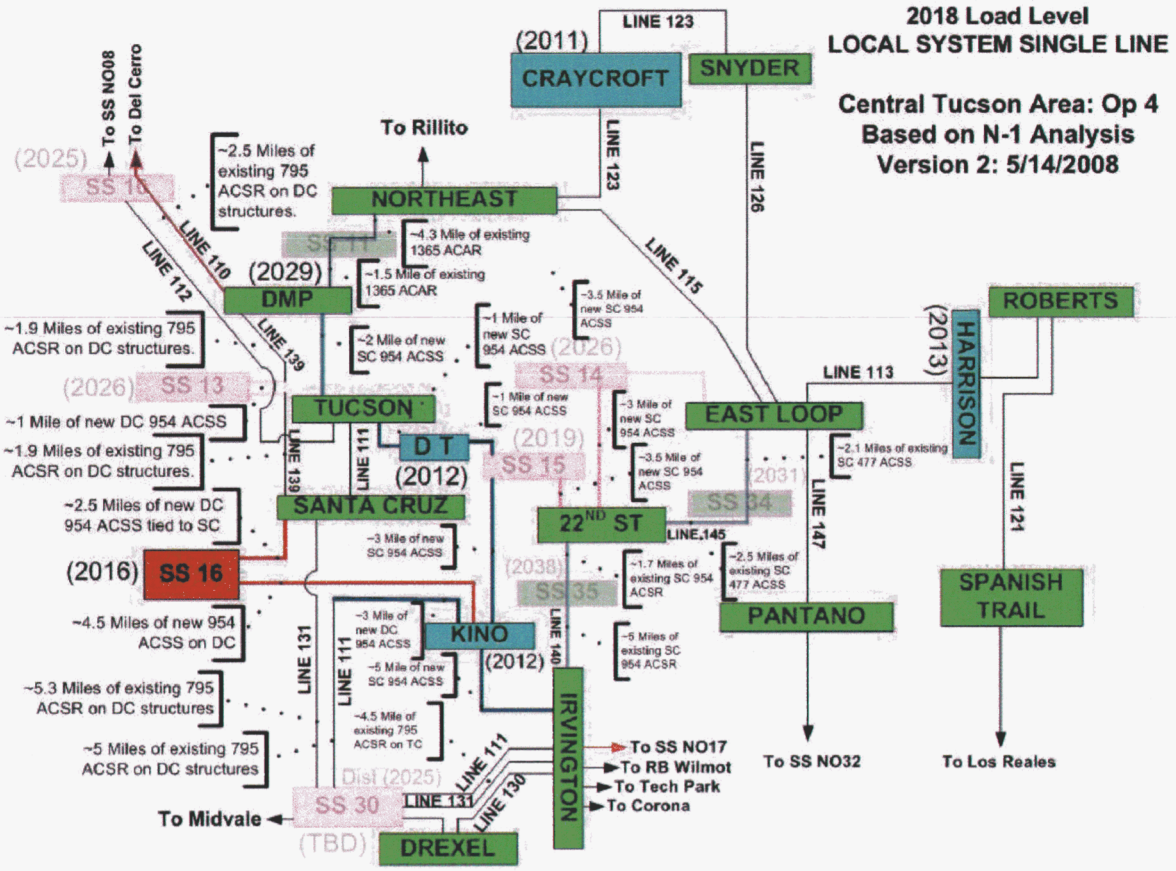


Figure 33. Central Tucson Area – Option 4

Option 5 was created to provide an alternative that could maximize transfer capability from Irvington into the downtown area. This would only be needed if downtown area load density were to increase significantly over applicable jurisdictions' existing land use plans.

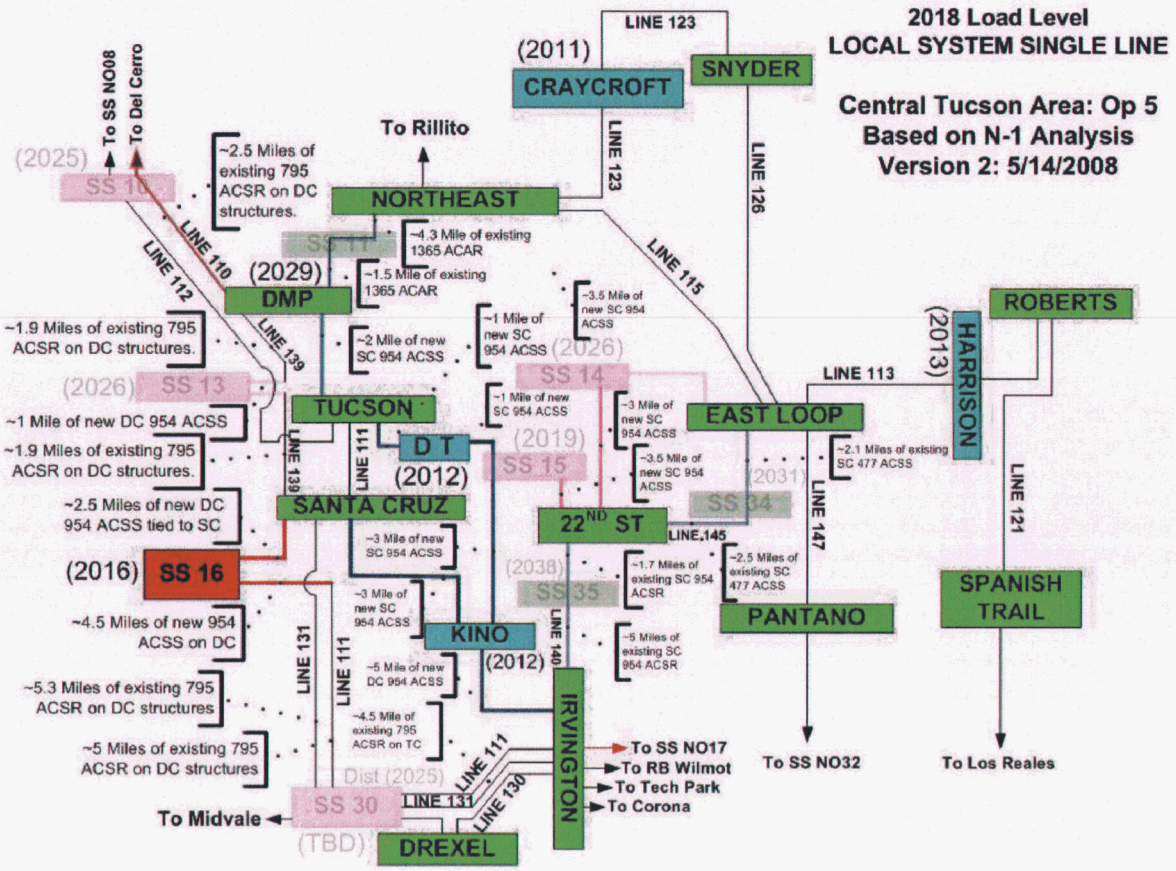


Figure 34. Central Tucson Area – Option 5

The SS 30 site was qualitatively evaluated in three potential contexts. One was as the site of a new EHV substation as defined by Strategies A, B, C and D. This is also a potential location for a new distribution substation. However other distribution substation locations will be pursued to limit the scale of any proposal involving EHV. The third alternative entailed construction of a 138kV switching station. The switching station however, did not offer sufficient benefits, such as deferral of elimination of new or uprated 138kV lines to justify the investment.

South Central Tucson Area: The South Central Tucson Area, shown in Figures 35 and 36, was investigated to identify viable alternatives to add new load serving substation capacity as well as options to ensure adequate 138kV system load serving capability. All new load serving substations may be sited close to existing 138kV lines except SS

17. Two distinctly different alternatives were proposed to supply SS 17. The first, shown in Figure 35 creates a new 138kV line from Vail to Irvington along the border of the Davis-Monthan Air Force Base.

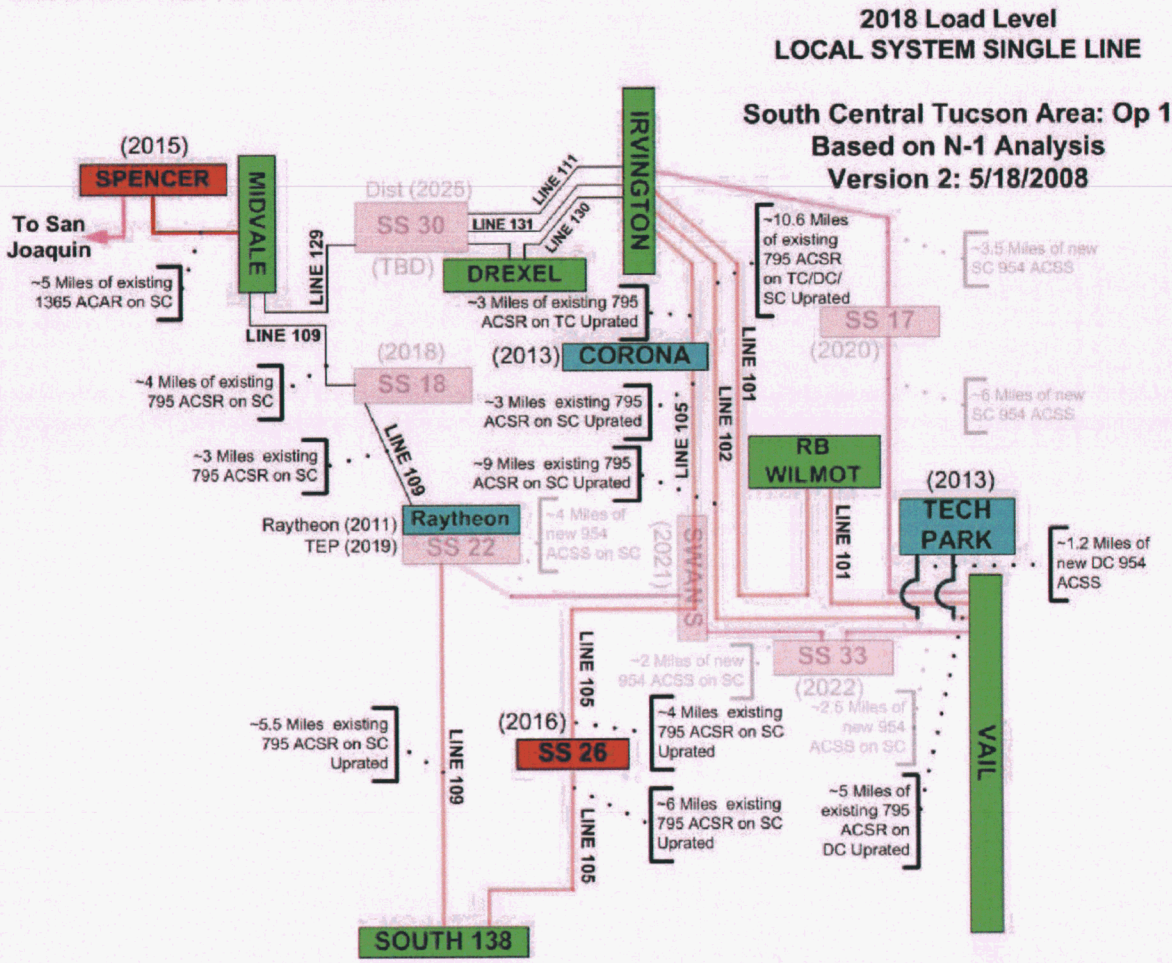


Figure 35. South Central Tucson Area – Option 1

The advantage of the new line is that it relieves loading on the existing 138kV lines between Vail and Irvington, and thereby increases capability into the load center. The problem is that the existing Vail to Irvington lines will need to be uprated within the five to ten year planning horizon. Hence there is less cost saving to justify the investment in a new 138kV line.

The main disadvantage of the new line is that, similar to the proposal for a new North

Loop to Rillito line, it would make siting a new Vail to Irvington 345kV line as contemplated in Strategy F much more challenging.

The second option shown in Figure 36 would supply SS 17 by a tap connected to Vail and RB Wilmot. Since these rather extensive facilities would be constructed primarily to supply the new substation, other options, including relocating the substation or supplying the growing load from distribution out of other substations should be investigated.

Both options envision uprating existing lines from Vail to Irvington, from South Loop to Irvington and from South Loop to Midvale. These uprates provide system benefits as well as connectivity to future load serving substations.

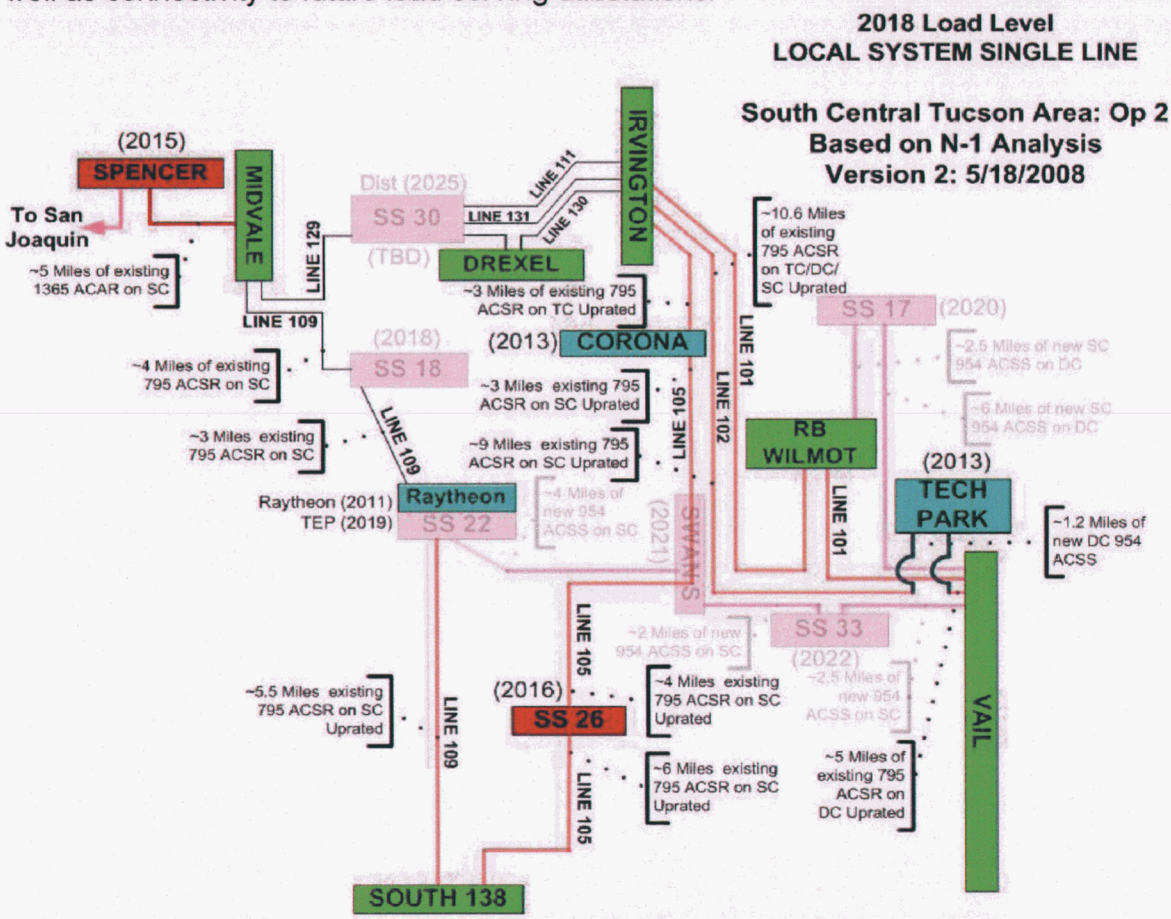


Figure 36. South Central Tucson Area – Option 2

Southeast Tucson Area: Four options were developed to try to address the complexities of serving the system east of the Davis-Monthan Air Force Base (D-M). The base is relatively large, with airspace restrictions, and therefore transmission facilities may not be constructed across the facility or within the flight paths. The impact is that line outages on either side result in overloads of lines transmitting power from the opposite side. For example, loss of Lines 108 and 103 from Vail shown in Figure 37 results in all of the system east of D-M being supplied from the East Loop substation (Refer to Figure 34 for the East Loop configuration). This outage therefore overloads the lines from Vail to Irvington, from Irvington to Twenty Second Street to East Loop, and from East Loop to Pantano to Los Reales.

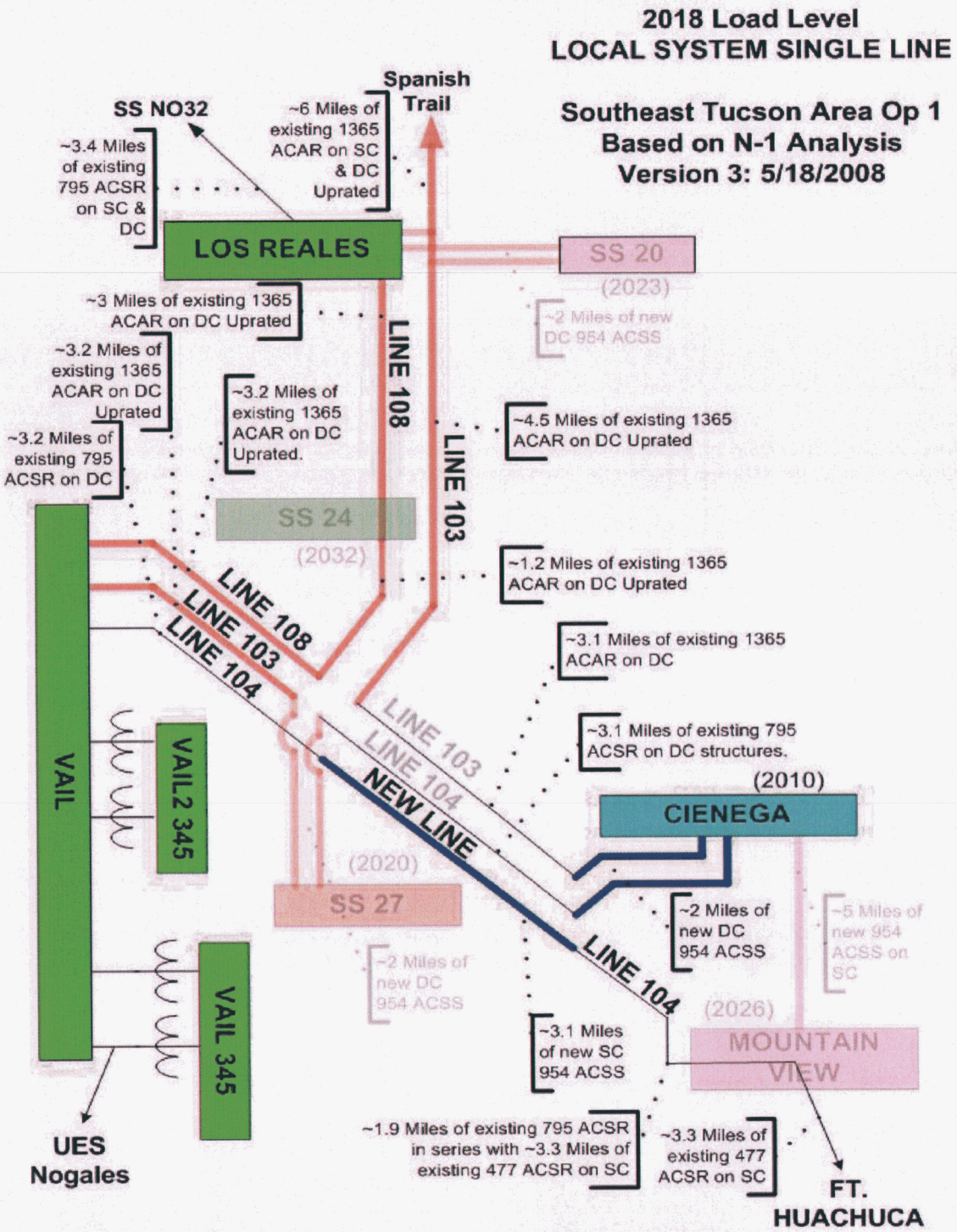


Figure 37. Southeast Tucson – Option 1

On the other hand, outage of the lines from Vail to Irvington or Irvington to Twenty Second Street cause stress on the lines from Vail to Cienega and Vail to Los Reales. There are also instances wherein the entire path from Vail to Los Reales to Pantano to East Loop becomes stressed. Additionally, a bus differential operation on the Irvington main-and-transfer bus will result in heavier overloading on the same 138kV lines between Vail and East Loop.

Variations of interconnecting new substations such as SS 27 to Line 104 versus Line 103 were considered and shown in Figures 37 and 38.

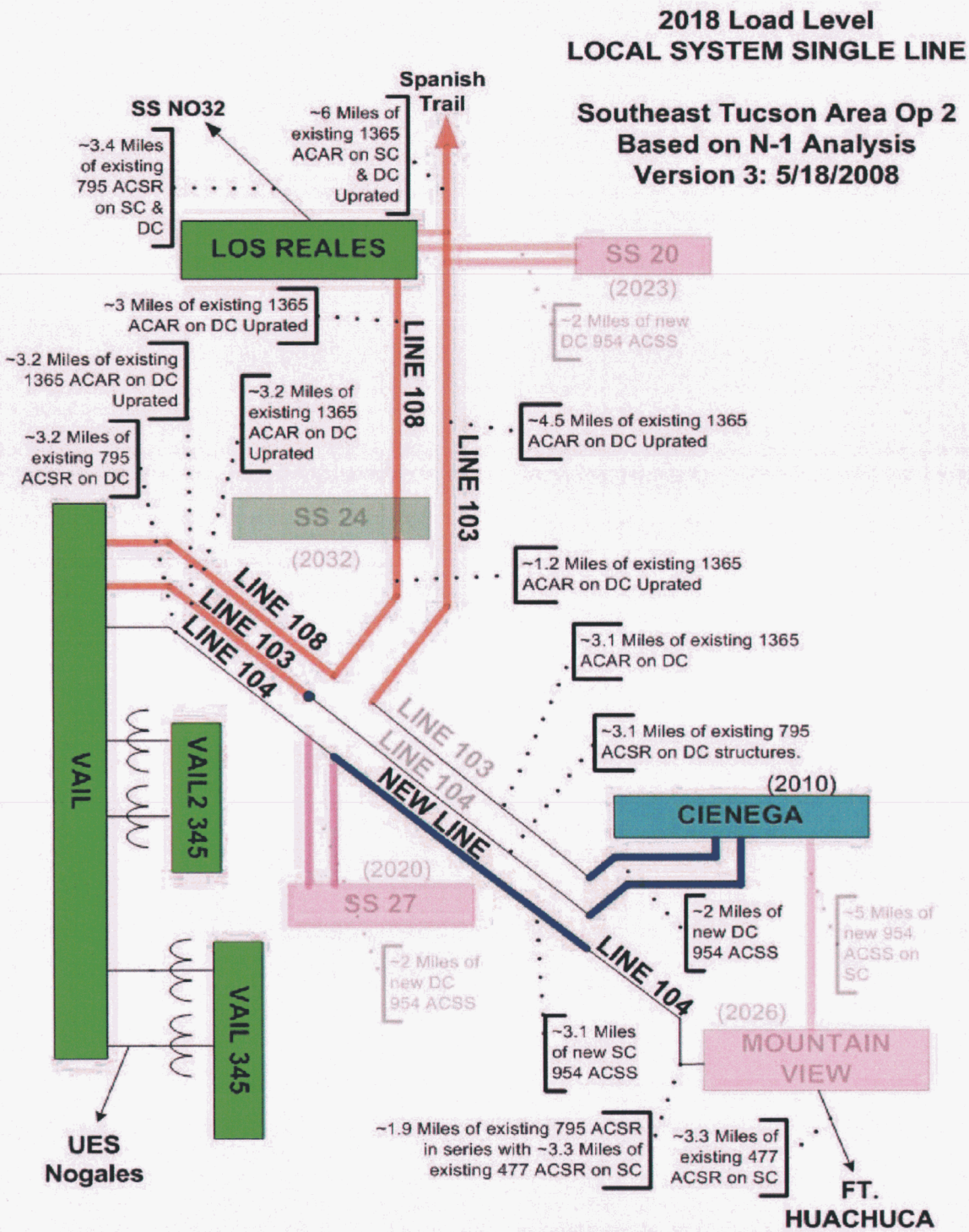


Figure 38. Southeast Tucson – Option 2

The actual configuration for SS 27, and SS 20 will be determined when time for need for either appears eminent within the ten year planning horizon.

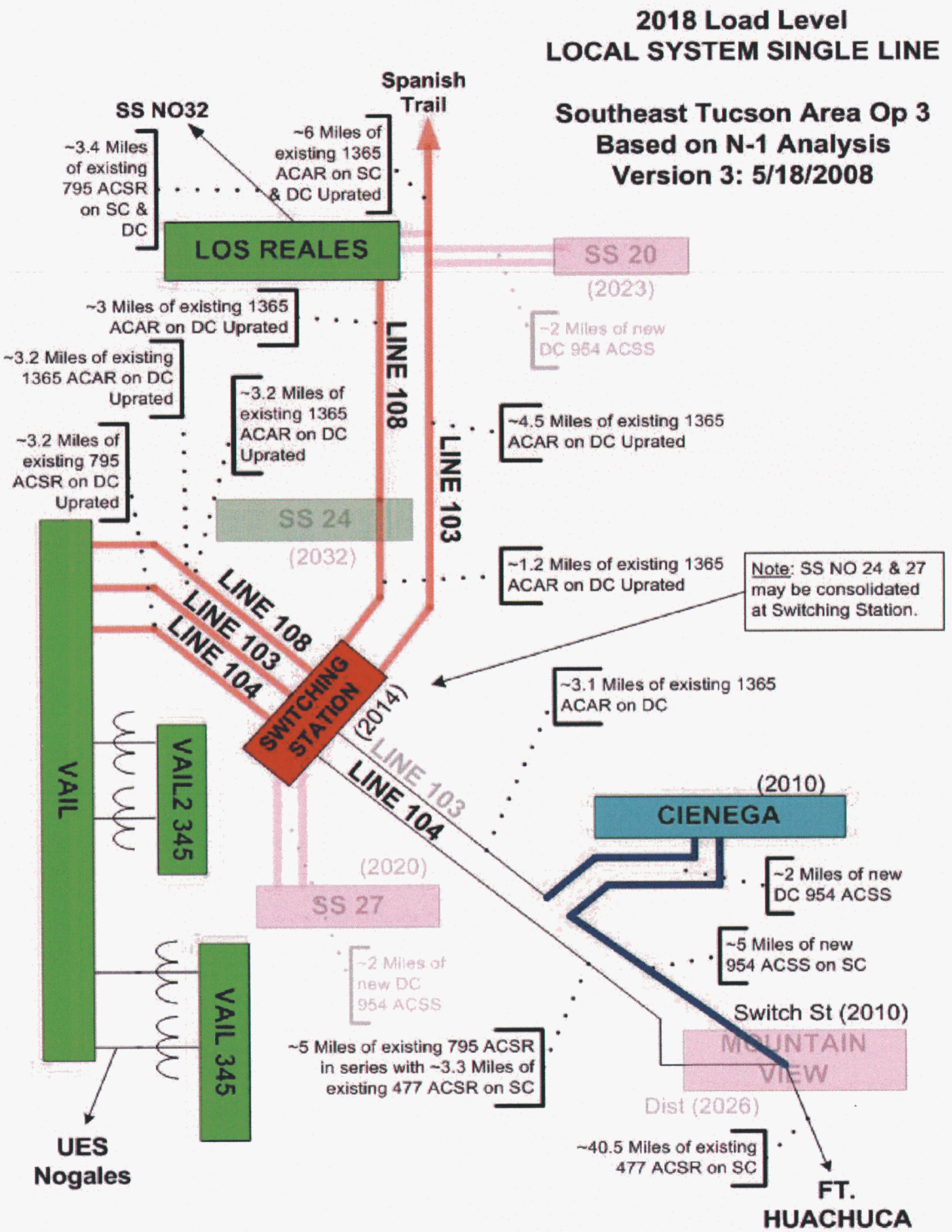


Figure 39. Southeast Tucson – Option 3

A 138kV switching station at the location where Lines 103 and 108 turn north from the line going to Ft. Huachuca was considered in an attempt to defer or possibly eliminate new line construction or uprates. While the switching station does not appear to be justified, it may make sense to consolidate SS 24 and SS 27 at that location.

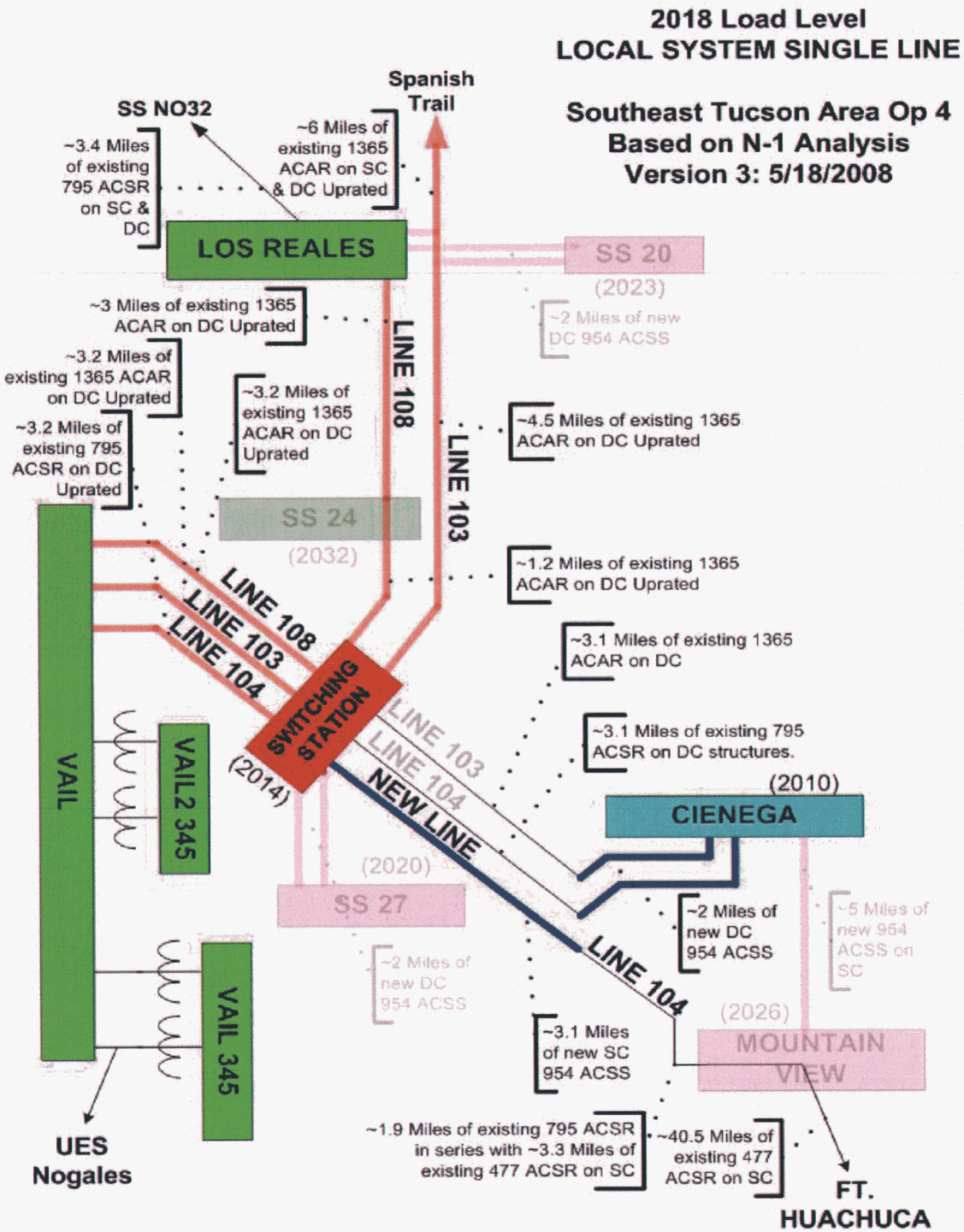


Figure 40. Southeast Tucson – Option 4

The Mountain View substation is located in an area that local jurisdictions are considering as conservation areas. As such, efforts to pursue this site or the Cienega to Mountain View corridor will be put on hold pending confirmation of land use plans for this area.

Southwest Tucson Area: This area will require in depth study to identify joint projects that may offer mutual benefits among TEP, Trico and SWTC.

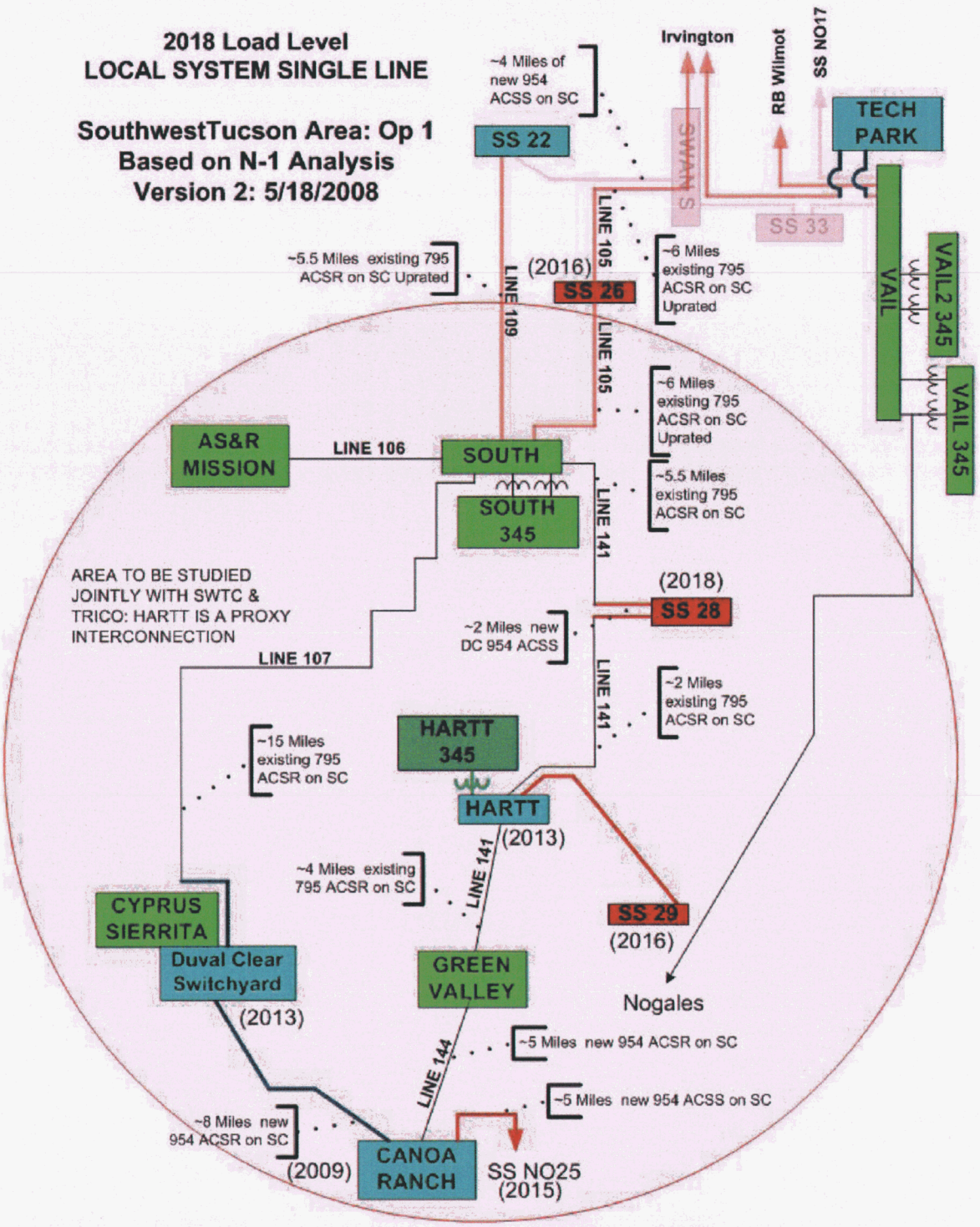


Figure 41. Southwest Tucson

An explanation of this area is included in Section 15.2 South of Tucson.

20.1. SWTC Strategies

SWTC does not anticipate sponsoring any major EHV projects, therefore its EHV strategies were dependent on other SATS participants EHV strategies. Since TEP was the only SATS participant with EHV strategies SWTC reviewed the TEP alternatives to evaluate which ones, if any, would be beneficial to the SWTC system. SWTC's backbone transmission system is composed of 230-kV and 115-kV lines originating from the Apache Switchyard (all generation at Apache is owned by Arizona Electric Power Cooperative). While WESTERN, APS, and TEP own transmission facilities in Cochise County, SWTC only has direct transmission interconnections in southeastern Arizona with TEP and WESTERN

This interconnected transmission system is used by TEP, Trico, SSVEC, GCEC, DVEC, APS, Safford, Thatcher, Avra Valley Irrigation and Drainage District, Silverbell Irrigation and Drainage District, and Morenci Water and Electric to serve their customers.

Fort Huachuca, a TEP retail customer in Cochise County, has expressed a need to improve service reliability. TEP, SSVEC, Fort Huachuca, and SWTC have discussed mutually beneficial projects, such as the Buffalo Soldier/Ft. Huachuca project, which may provide the additional backup service Fort Huachuca is seeking. Back up service, if interconnection facilities are constructed, would be provided under TEP contractual rights on the SWTC transmission system.

SWTC, SSVEC and APS have worked together to develop the present emergency tie at McNeal for backup service. Discussions between these companies to provide for joint participation in mutually beneficial projects continue today such as the future emergency ties at Hereford/Palominas.

For the purposes of the SATS work, SWTC divided its system into three areas. The three areas of the system and their selected strategies for the area were evaluated under normal conditions and line outage conditions with SWTC's "Internal Planning Criteria and Facility Ratings". Utilizing GE's PSLF power flow study program, the analysis was conducted with extrapolated 2027 (2008 to 2027, 20 year transmission

plan) summer peak loads for SSVEC, GCEC, DVEC, APS, Safford, Thatcher and Morenci since saturated loads were unavailable. TEP and Trico peak loads were at a saturated state. Due to the close proximity of the Trico and TEP loads a saturated scenario was beneficial. The transmission strategies for the Graham, the Cochise, and the Marana areas are the following.

20.1.1. Figure 42 Graham Area shows the DVEC, GCEC, SSVEC, Safford and Thatcher load areas that are identified by the study as the Graham Area. New facilities proposed in the next six years are identified in red. They are Hackberry to Thatcher, Hackberry to San Jose and Stewart to Mortenson 69kV lines and a second transformer at the Redtail Substation. The Graham Area load was 445 MW for the "2027 analysis". This analysis found that additional facilities and upgrades were needed to support the loads. Among the issues was the need to upgrade some 69kV lines, additional shunt capacitors and transformers. Table 21 shows the needed facilities.

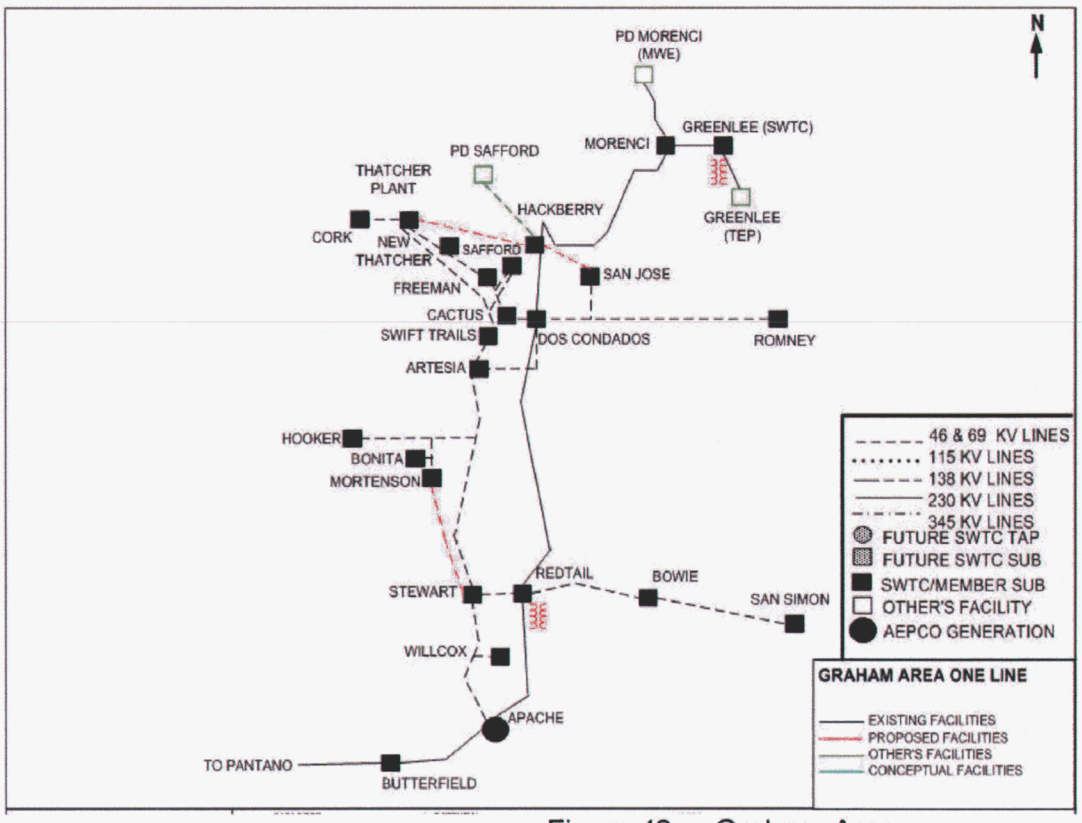


Figure 42. Graham Area

20.1.2. Figure 43 Cochise Area shows the SSVEC load areas that are identified by the study as the Cochise Area. The 69kV facilities under consideration by SSVEC, which are identified in red on the following figure, are:

- Stewart to Mortenson
- Sloan to Mescal[21]
- Sloan to Cottonwood
- Cottonwood to Guindani
- Guindani to St. David
- Kartchner to Sonoita
- Ramsey to Hereford
- Hereford to Palominas[22]

[21] The proposed Sloan 230kV substation would be constructed, owned and operated by SWTC. Any connections to this substation will be dependent upon the timing of its construction.

- A second transformer at Redtail Substation

Potential 69kV substations:

- Sunsites
- Cottonwood
- Guindani
- Sonoita
- Sierra Vista II
- Hereford

Figure 43 includes a SWTC placeholder (the 230kV line from Pantano to San Rafael, shown in blue) to address a reliability issue (loss of the San Rafael source) in the near-term. . A subcommittee of SATS was formed to determine the most economical, feasible and robust alternative. The result of that work is found in Section 22. Cochise County Study of this report. A long-term solution is given here for the Cochise Area load of 428 MW for the "2027 analysis". Additional facilities and upgrades were needed. They include 230kV line additions, 69kV line upgrades, additional shunt capacitors and transformers. Table 22 shows the needed facilities.

[22] This line will provide a second emergency tie with the APS system. As with the existing McNeal tie, this line will normally be open and require operator intervention to close in emergency situations.

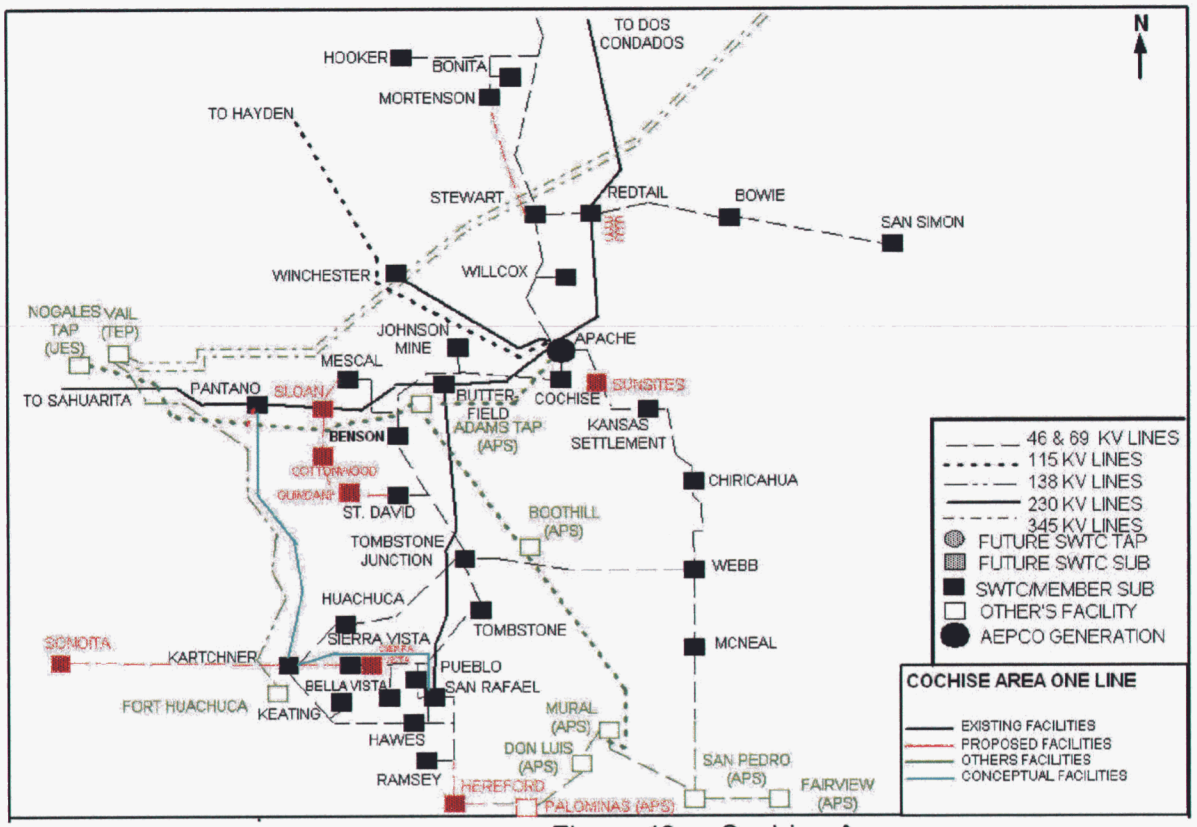


Figure 43. Cochise Area

20.1.3. Figure 44 Marana (Pima and Pinal County) Area shows the load areas that are identified by the study as the Marana Area. New facilities proposed in the next few years are identified in red. Conceptual facilities under study are identified in blue.

Proposed new substations include New Tucson 230/24.5kV, Adonis 115/24.9kV, and San Joaquin 115/24.9kV.

New 115kV lines include: (1) Saguaro to Adonis to Rattlesnake; (2) looping the existing CAP Sandario to Brawley line into SWTC Sandario Substation (SWTC Sandario to CAP Sandario and SWTC Sandario to Brawley); (3) looping the Rattlesnake to CAP Sandario line into the Picture Rocks Substation; (4) looping the Brawley to San Xavier line into San Joaquin Substation (Brawley to San Joaquin and San Joaquin to San Xavier); and (5)

constructing a new SWTC Valencia to Black Mountain line.

Additional new 115kV line projects also proposed include: (1) looping the existing SWTC Apache to Hayden line into the APS San Manuel Substation (Apache to San Manuel and San Manuel to Hayden); and (2) looping WESTERNs' 115kV line at both of the existing SWTC Marana and Pantano Substations.

Proposed 230kV line projects include construction to loop the Pantano to Sahuarita 230kV line into New Tucson. Potential new 69kV lines include Saddlebrooke Ranch to Willow Springs and Saddlebrooke Ranch to Eagle Crest.

Conceptual projects also include the potential CS-1 project. This project includes: 345/230/115kV Substation; CS-1 to Three Points line; additional conductor to loop the Pinal West to South 345kV line into CS-1; and a new 230kV line from CS-1 to Bicknell.

The Marana and surrounding Tucson Area load was 6,946 MW for the "saturated state analysis". TEPs' load was modeled at 5,668 MW and Trico load was modeled as 1,247[23] MW. CAPs' load was modeled at 31 MW. Additional facilities and upgrades examined include 500kV, 345kV or 230kV line additions, 115kV and 69kV line upgrades, additional shunt capacitors and transformers and new substations. Table 22 shows the needed facilities.

Of the three areas that SWTC provides transmission service in this study, the Marana Area was the one that SWTC saw potential benefits from the TEP EHV strategies. There were possible joint projects identified such as 345kV facilities connecting Tortolita, Marana, Three Points and Bicknell. A 345kV line between North Loop and Tortolita has possible benefits to SWTC. These EHV strategies will need to be thoroughly evaluated both

[23] Trico has revised its saturated load to 1465 MW. The new saturated load may be studied in the 2009 SATS Study Plan.

economically and technically.

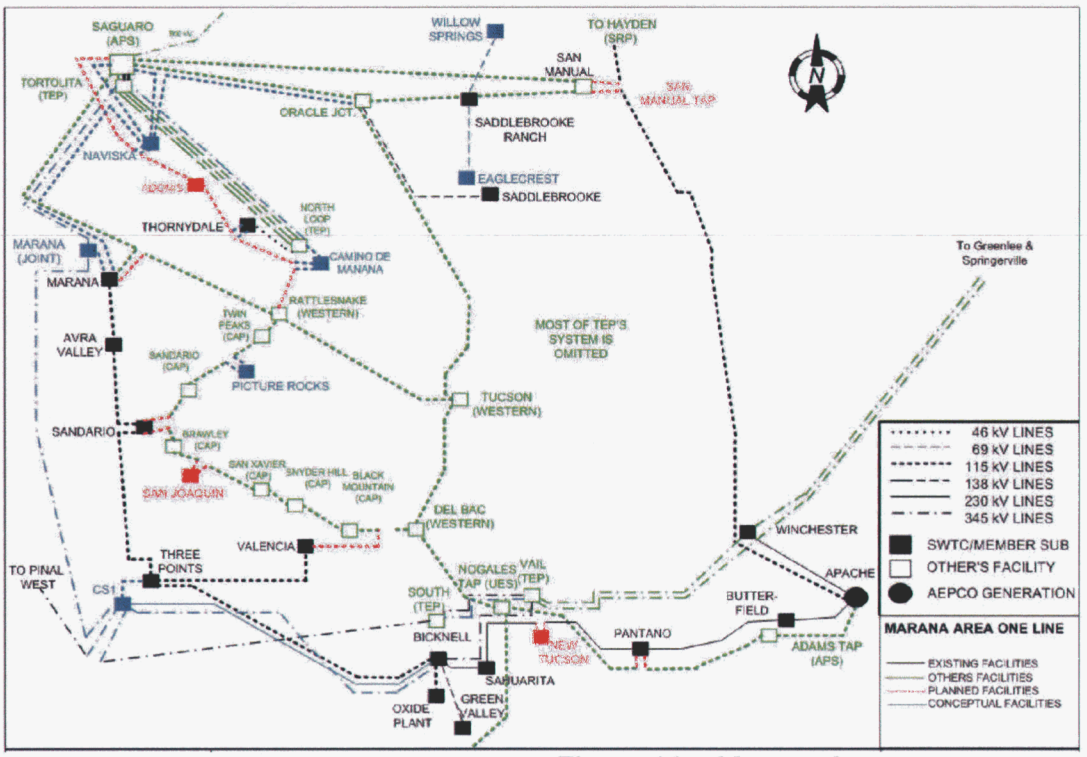


Figure 44. Marana Area

Facility	Line Upgrades and Additions	Shunt Capacitor	Transformer
Hackberry 230kV		50 MVAr	
Cork 69kV		30 MVAr	
Cork Tap to Cork 69kV line	11.2 miles		
Dos Condados Substation			230/69kV 50 MVA
Greenlee Substation			345/230kV 200MVA
Redtail to Stewart 69kV line	4.5 miles		

Facility	Line Upgrades and Additions	Shunt Capacitor	Transformer
Bonita to Bonita Tap to Mortenson 69kV line	3.0 miles		
Bonita 69kV		30 MVAr	
Kartchner to Sierra Vista 69kV line	1.3 miles		
San Rafael 69kV		36 MVAr	
Pantano to Kartchner 230kV line	36 miles		
Kartchner to San Rafael 230kV line (new line)	8 miles		
Boothill Substation			115/20.8kV
San Pedro Substation			69/12.5kV
Mural Substation			115/69/12.5kV
Don Luis Substation			69/12.5kV
Thornydale Substation			115/24.5kV 50 MVA
Thornydale 115kV		76.8 MVAr	
Adonis Substation			115/24.5kV 50 MVA
Naviska Substation			115/24.5kV 50 MVA
Saguaro to Naviska 115kV line (new 2nd circuit)	5.0 miles		
Oracle to Saddlebrooke 69kV line	12.5 miles		
Saddlebrooke Ranch Substation			115/24.5kV 50 MVA
Saddlebrooke Ranch Substation			3 @115/69kV 50 MVA
Saddlebrooke Ranch 115kV		76.8 MVAr	
Marana Substation			3 @115/24.9kV 50 MVA
Avra Valley Substation			115/24.5kV 50 MVA
Sandario Substation			2 @115/24.9kV 50 MVA
San Joaquin Substation			2 @115/24.9kV 50 MVA
San Joaquin 115kV		76.8 MVAr	
Valencia Substation			2 @115/24.9kV 50 MVA
Valencia 115kV		57.6 MVAr	
CS 4 Substation (Hodgers)			2 @115/24.9kV 50 MVA
CS 4 115kV (Hodgers)		38.4 MVAr	
Bicknell 115kV		38.4 MVAr	
Bicknell Substation			115/69kV 50 MVA

Facility	Line Upgrades and Additions	Shunt Capacitor	Transformer
Sahuarita Substation			2 @115/24.9kV 50 MVA
New Tucson Substation			115/24.5kV 50 MVA
New Tucson 230kV		100 MVAr	
New Joint Marana Substation			345/115kV 672 MVA
Tortolita to Marana 345kV line (new)	12.0 miles		
Marana to CS 1 345kV line (new)	29.0 miles		
Saguaro to Marana	12.0 miles		
Saguaro to Oracle	19.0 miles		
Coolidge to Valley Farms	5.2 miles		
Marana to Rattlesnake	7.7 miles		
Three Points to Valencia	11.5 miles		
SWTC Sandario to Brawley	1.2 miles		
CAP Sandario to SWTC Sandario	4.2 miles		
Oracle to Saddlebrooke Ranch	3.5 miles		
Rattlesnake to Twin Peaks	0.5 mile		
Twin Peaks to CAP Sandario	7.7 miles		
Brawley to San Joaquin	7.6 miles		
Adams to Boothill	19.2 miles		
Saguaro to Naviska circuit 1	5.0 miles		
Saguaro to Naviska circuit 2	5.0 miles		
Winchester to Vail circuit 1	39.9 miles		
Winchester to Vail circuit 2	39.9 miles		
Redtail Substation			230/69kV 50 MVA
Bicknell Substation			230/115kV 100 MVA
Tortolita Substation			500/345kV 672 MVA
Winchester Substation			500/345kV 900 MVA

Table 22. SWTC[24] Facility Additions

[24] The additions were not at solely owned SWTC facilities. Ownership resided within participants of SATS. Listing of facilities, new additions and upgrades, provided information needed for the long-term planning study.

21. Findings from Power Flow Analyses

21.1. 2010 Case Analysis: The 2010 cases assume that only those upgrades that are presently funded through approved capital improvement plans or other projects that are otherwise considered highly likely candidates to be funded and constructed by 2010, are in place.

- CAP has requested an interconnection with the SWTC system before December 2010. The CAP system has five pumping substations located in the Marana and surrounding Tucson area of Arizona with a peaking load of 60 MW. The CAP system is fed by a 115kV radial system from WESTERN's Rattlesnake Substation. The interconnection of the SWTC and CAP facilities has value to both the CAP system and the SWTC transmission system. Currently CAP has non-firm service from WESTERN and will be requesting firm transmission service in December of 2010. The radial configuration of the CAP load has proved to be an issue in contingency analysis preformed by SWTC. The interconnections will loop both the CAP and SWTC systems creating a more reliable configuration. An alternative may be an Interconnection with TEP (which will require a 138/115kV transformer).

Benefits for the SWTC system to interconnecting with the CAP system includes improved system reliability. The proposed interconnections will provide SWTC an additional source for its existing 115kV system. Currently SWTC's 115kV system has two sources one at Marana and one at Bicknell. By creating this loop it will allow SWTC to take outages in order to upgrade the existing system. The loop will allow SWTC to grow and meet its member and other customer load requirements. Other alternatives that may prove to be more costly and less beneficial to both SWTC and its members include:

- Upgrade of WESTERN's existing system
- A 138/115kV interconnection with TEP
- Construction of new transmission or sub-transmission lines.

As discussed above, interconnection between CAP and SWTC proved to be

beneficial to both entities. Facilities will be jointly owned, operated and maintained. The looped configuration will add increased reliability to both CAP and SWTC systems. It is important to recognize that the final 2009-10 Construction Work Plan may vary significantly depending upon more current assessments of the state of the economy and other critical factors.

21.2. 2010 TEP Case Analysis

TEP upgrades consist of the addition of a new 500/345kV substation at Pinal West plus an SVC at Northeast to provide voltage stability to the TEP 138kV network, both in 2008. The 138kV transmission projects in Figure 45 show the system additions that were presented for inclusion in the TEP preliminary 2009-13 Capital Budget. It is important to recognize that the final 2009-13 Capital Budget may vary significantly depending upon more current assessments of the state of the economy and other critical factors.

During the process of preparing the five year capital budget, TEP determined that existing 138kV facilities between Tortolita and North Loop would limit load serving capability from the relatively strong source at Tortolita. Therefore significant upgrades were proposed in the Tortolita to North Loop corridor. They were recommended because of relatively high load growth and the need to increase 138kV transfer capacity from Tortolita. These upgrades consisted of a series of projects staged over the three year period, 2008 – 2010:

- Prior to 2008 the Tortolita to North Loop and Tortolita to Rancho Vistoso corridor consisted of two 138kV lines between Tortolita and North Loop plus one additional circuit between Tortolita and Rancho Vistoso

- In 2008 the existing Tortolita to Rancho Vistoso line was modified to create a third Tortolita to North Loop circuit and a North Loop to Rancho Vistoso line.

- In 2010, the plan is to reconstruct the two original Tortolita to North Loop lines on a "quad" circuit pole-line, including an additional 138kV circuit and a 115kV circuit for SWTC to this structure. For the TEP system, this results in three Tortolita to North Loop circuits on the "quad" pole-line and one Tortolita to North Loop 138kV line as a single circuit pole-line.

Additional 138kV projects modeled in the 2010 case are listed below:

- Northeast 138kV Static VAR Compensator, 2008 – a detailed voltage stability study indicated the need for a -75/+200 MVAr SVC

- Del Cerro 138/13.8kV Substation, 2008 – a load serving substation served by tapping the existing West Ina-Tucson 138kV line.

- DMP-Tucson 138kV Circuit, 2010 – new 138kV transmission to mitigate a local instability condition under contingency conditions.

- Catalina, renamed the Sun City 138/13.8kV Substation, 2010 – a load serving substation served by a new 138kV transmission radial out of the existing Rancho Vistoso substation.

- Cienega 138/13.8kV Substation, 2010 – a load serving substation served by modifying the existing Vail-Spanish Trail and Vail-Fort Huachuca 138kV lines.

- Canoa Ranch 138/13.8kV Substation, 2009 – a load serving substation served by a new 138kV transmission radial out of the existing Green Valley substation.

- Kino 138/13.8kV Substation, 2012 (subsequently moved to 2014 during the 2009 capital budget process[25]) – a load serving substation served by tapping a new Irvington-Tucson 138kV line. Previously reviewed with a 2010 in-service date, this project was then deferred to 2012, and finally 2014.

These projects were modeled in cases beyond 2010, initially by TEP to prepare the five year capital budget, as well as all SATS cases.

[25] The analysis for SATS, and documented in this report does not reflect changes implemented during the 2008 five year capital budgeting process. However, the SATS analysis and results, as documented in this report provided the initial screening for the budget analysis.

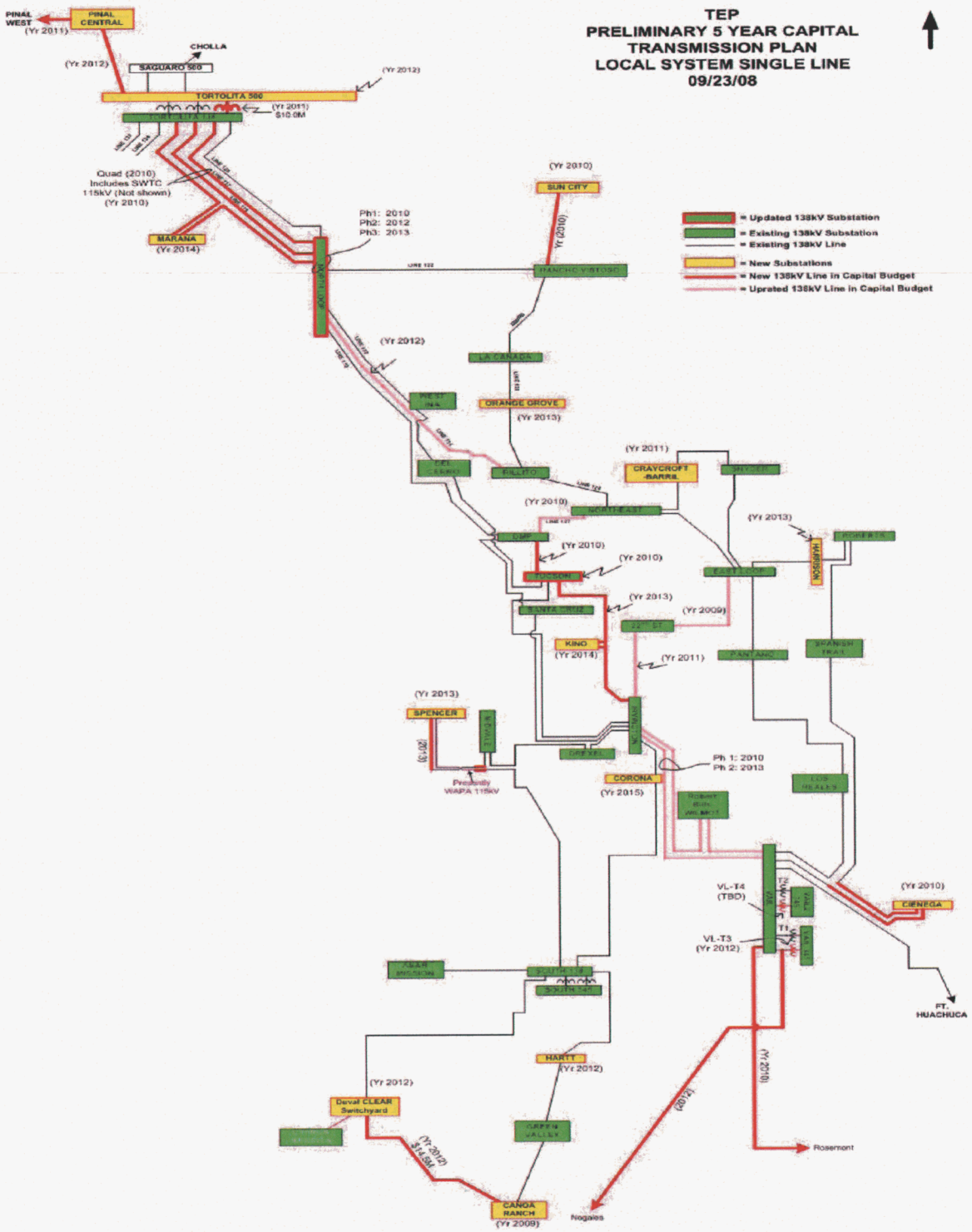


Figure 45. TEP 2009-2013 Preliminary Capital Projects

21.3. 2010 SWTC Case Analysis

2009-2010 Construction Work Plan (CWP) includes upgrades of SWTC's existing system as well as joint projects between SWTC and others.

Joint projects with CAP include the addition of two new substations, San Joaquin and Adonis, re-conductor of the existing Avra-Marana 115kV line and construction of a new 115kV line from Saguaro to Rattlesnake. Joint projects also include the SWTC and WESTERN construction of a new interconnection at the existing SWTC Pantano substation to the existing WESTERN 115kV line from Adams Tap to Nogales Tap.

The 115kV and 230kV projects in Figure 44, show the system additions that are described in the SWTC 2009-2010 CWP.

The joint projects between SWTC and CAP will improve reliability, as well as increase the capability of certain portions of the SWTC system by continuing to re-conductor older transmission lines. New delivery points were considered necessary due to the increasing loads within Southeast Arizona. The following describes the SWTC projects currently anticipated:

- Joint Projects related to the SWTC and CAP systems (2010)
    - Upgrade the SWTC Sandario substation
    - CAP system loop in at the SWTC Sandario substation
    - Construction of the San Joaquin substation
    - New 115kV line to loop the San Joaquin substation into the Brawley and San Xavier substation
    - New switchyard at SWTC Valencia substation
    - Construct a new 115kV line from the CAP line termination east of Black Mountain substation to the existing SWTC Valencia
    - New Saguaro to Rattlesnake 115kV line
    - New Adonis substation
    - Upgrade of the Rattlesnake substation
- New Tucson substation (2010) and loop in of SWTC existing 230kV line between Pantano and Sahuarita substations
- Marana to Avra Valley 115kV line upgrade to 1272 ACSR (2010)

Using the findings of the SATS 2010 base case SWTC has since modeled cases with these upgrades in order to prepare documentation for the 2009-2010 CWP.

WESTERN upgrades consist of the list of projects Shown in Table 23. WESTERN SATS Construction Potential.

Western SATS Construction Potential	
Project	**Energize**
Empire Tap Upgrade	2010
ED5 Sub Upgrade	2013
Casa Grande-Empire Upgrade	2014
ED4 Sub Ugrade	2015
Tucson Sub	2015
ED5 to Empire 115kV TL	2016
ED2 Sub Upgrade	2016
Coolidge to ED2 No 1 15 kV TL	2018
Coolidge to ED2 No 2 115 kV TL	2017
UPGRADE 9.2 MILES OF POLES AND CONDUCTOR ED4-ED5 115 KV TL	2018
UPGRADE 9.2 MILES OF POLES AND CONDUCTOR ED2 - ED4 115KV TL	2018
ORACLE-SAGAURO 115kV UPGRADE	2018

Table 23. WESTERN SATS Construction Potential

21.4. 2016 Case Analysis: Combinations of EHV and local area transmission projects that made sense based on the experience and judgment of TEP and SWTC transmission planners were added to the 2016 cases. This was to make reasonable efforts to identify which projects would be required for load serving capability based on information available at that time. This work was done prior to development and analysis of any saturation load level cases. Development of the 2016 case resulted in a nominal transmission configuration to establish a benchmark upon which to build a revised 10-year (2018) planning horizon case.

TEP upgrades consist of the participating Pinal West to Pinal Central and SEV 500kV project and adding a new Pinal Central to Tortolita 500kV line plus a third 500/138kV transformer at Tortolita. Additional 345kV transmission will also be needed to increase load serving capability into Tucson. While a decision as to which EHV project had not been made, TEP modeled a new Tortolita to East Loop 345kV with a new 345/138kV substation at East Loop. Tortolita to East loop was modeled as it was included in the TEP Preliminary EHV Transmission Plan. As the SATS study progressed, TEP switched its focus to Strategies C and F in the 2018 cases that replaced the 2016 work. The following projects are part of the 2016 case in addition to those that are represented in the 2010 case:

- Corona 138/13.8kV Substation, 2013 – a load serving substation served by tapping the existing Irvington to South 138kV line.

- U of A Tech Park 138/13.8kV Substation, 2013 (subsequently moved beyond the 5 year capital budget time frame) – a load serving substation served by tapping the existing Vail to Irvington 138kV line.

- Spencer 138/47.2/13.8kV Substation, 2013 – a load serving substation served by extending the existing Midvale to South 138kV line west ~8 miles along Valencia Rd.

- Marana 138/13.8kV Substation, 2013 (subsequently moved to 2014) – a load serving substation served by tapping one of the Tortolita to North Loop 138kV circuits and extending it as a double-circuit pole-line west across I-10 to the substation.

- Craycroft-Barril 138/13.8kV Substation, 2011 – a load serving substation served by tapping the existing Northeast-Snyder 138kV line.

- Hartt 138/13.8kV Substation, 2012 – a load serving substation served by tapping the existing South to Green Valley 138kV line.

- Harrison 138/13.8kV Substation, 2013 – a load serving substation served by

tapping the existing East Loop to Roberts 138kV line.

- Tucson 138/13.8kV Transformer Replacement, 2008 – replace the existing transformer at Tucson Station with a higher rated unit.

2016 SWTC Case Analysis: Potential upgrades considered by SWTC consisted of:

- Participation in the Pinal West to Pinal Central 500kV project and the Pinal Central to Tortolita 500kV project;
- Interconnection of TEP's line from Pinal West to South 345kV line;
- A 230kV injection point or loop into the SSVEC area;
- Upgrade of the 115kV lines from Bicknell to Three Points and Avra to Sandario to Three Points.

Using the 2016 SATS base case, SWTC identified a number of potential upgrades as well as a number of possible interconnection points to evaluate in the 2011-2013 CWP process. Projects beyond the 2010 planning period remain conceptual and subject to change as future demands increase or decrease during evaluation.

2011-2013

- Avra Valley to Sandario Tap 115kV line upgrade to 1272 ACSR
- Marana Tap to Marana 115kV line and Marana substation upgrade
- Pinal West to Pinal South Transmission Line Project
- Pinal South to Tortolita Transmission Line Project
- Redtail Substation Upgrade
- Sandario Tap to Three Points 115kV line upgrade to 1272 ACSR
- Second 230/69kV Transformer at San Rafael

2014-2026

- Picture Rocks and Naviska substations
- CS1 Substation
  - New substation with 345/115kV transformer
  - Line tap from Pinal West to South 345kV line
- SSVEC 230kV line project

21.5. 2018 Case Analysis: The 2018 base cases evolved from the Saturation cases. The first to be completed modeled the Strategy A EHV topology with a complementary 138kV configuration. Strategy C and F were also evaluated. In order to maintain flexibility, TEP 138kV local area system plans include reinforcement of the double and triple circuit lines emanating form the Tortolita and Vail EHV delivery points. Other critical 138kV paths such as those supplied from the Irvington substation are also designated for uprates, plus at least one new line from Irvington to Tucson, within the ten year horizon. Because of these plans, and the observation that there is no evidence of flow-through on the 138kV system, there is little difference in the 138kV system design among the alternative EHV strategies.

Modeling for the Strategy A 2018 case began with the observation that the forecast load at 50% of saturation approaches the load forecast for the 2016 time-frame. This observation was used to determine that portion of the substation and/or transformer capacity identified at saturation that would be required to serve load at the 50% point and subsequently the 10-year planning horizon, 2018. Only the EHV upgrades that were required to serve the load in 2018 were included. Initially two EHV options that yielded comparable Load Serving Capability were evaluated; the first being Tortolita to North Loop, and the second Tortolita to East Loop 345kV. Evaluation of these two options indicates that there are significantly greater impacts to the underlying 138kV system by terminating the EHV at North Loop than at East Loop.

Analysis of Strategy C and F indicates that the issues identified in Section 15.1 Greenlee to Vail EHV and 230kV Corridor Area must be resolved prior to 2018, with interim solutions implemented in the 2014 time frame, assuming the 2008 load forecasts. The most critical outage is loss of the Springerville – Vail 345kV (Express) line and the Winchester – Vail 345kV line which causes excessive loading on the parallel 230kV system. Other critical outages include loss of the Willow – Winchester 345kV line along with loss of the Greenlee – Willow 345kV line or the Express line or the Winchester – Vail 345kV line. Other outages involving the Vail T2 transformer, cause results similar to outage of the Express line.

Alternative EHV solutions include addition of a new double circuit 345kV line between Winchester and Vail, plus a new single circuit 345kV line from Winchester to Willow. The new lines between Winchester and Vail may be constructed along the existing corridor or parallel the SWTC 230kV facilities, perhaps involving reconstruction of the WESTERN 115kV lines.

These issues and solutions in the Greenlee - Vail corridor assume the Bowie generating station will be typically operating at 500 MW. Interim solutions, perhaps implemented in the 2014 time frame, that may be considered include tripping part or all of Bowie, a remedial action scheme involving tripping of the Bicknell transformer or adding new local generation in the Tucson area to reduce net load served by EHV and 230kV transmission. The 2018 case included higher than existing rating on the Apache to Butterfield 230kV plus loop-in at Pantano of the WESTERN 115kV line. These projects would partially mitigate post-contingency 230kV line overloads. Therefore these projects will be considered among the other alternatives in the 2009 SATS Study Plan.

If the Bowie project is not in service within the five year planning horizon (e.g. by 2012), then emphasis should be shifted to increasing transmission capacity into Tortolita from the west and northwest and reinforcing North Loop with EHV or 230kV. Alternatives coordinating with the SPPR project should be investigated wherein new 230kV facilities extending into Tucson from the Marana Tap could interconnect with the local area 115kV 138kV systems. Otherwise, the two 345kV joint project lines from Tortolita to North Loop along the TEP 138kV corridor plus the Tortolita to Marana Tap to North Loop utilizing the WESTERN 115kV corridor as in either Strategy C or Strategy F would meet the needs in the 2018 time frame.

21.6. 2028 Case Analysis: The cases modeling 2028 conditions assumed a relatively high bias toward resources supplied from southeast of the Tucson metropolitan area. The Bowie plant was operated at 500 MW and 400 MW of generation was added at the Winchester substation. The generation at Winchester simulated a relatively modest injection from the SunZia transmission project. The remaining resources were modeled by 120 MW and 150 MW

modeled at Pinal Central and Pinal West respectively.

The results indicate that a fourth 500/138kV transformer will be needed at the Tortolita substation. Also the major components of the "reach-in" strategies should be in service at about the twenty year planning horizon. Reinforcement into the northwestern Tucson area, whether it be two 345kV lines to North Loop as in Strategies C and F, or a variation involving 230kV as described in the 2018 case analysis above. Based on currently available information, TEP's preference would be for new 345kV lines from Vail to Irvington to South Loop with 345/138kV transformation at Irvington, or Strategy F. Otherwise Strategy C would be technically effective. Additional 345/138kV, 345 or 230/115kV and 345/230kV transformers will be need as well. More detailed analysis will be necessary to determine the number, size and timing for these various transformer additions.

At the 2028 load level, based on the 2008 load forecast, EHV reinforcement consisting of 345kV transmission additions into Vail from the east or into North Loop from the northwest would be adequate to serve SATS area load.

21.7. Saturation Case Analysis: The cases modeling saturated load conditions assumed a relative balance between resources supplied from northwest and southeast of the Tucson metropolitan area. Resources from the northwest were modeled as 1,000 MW at Hassaympa, 300 MW at Pinal Central and 300 MW at Pinal West. The generation at Winchester was increased to 1,500 MW and the Bowie plant was assumed off due to the higher level of uncertainty about Bowie at the time the analysis was done. Nevertheless, this case is still reasonable since Bowie and Winchester are relatively close to each other. The generation at Winchester simulated a higher level of injection from the SunZia transmission project than assumed for the 2028 base case.

Initial results indicated that the 345kV additions described in the 2028 case analysis would not be adequate to serve saturated loads. Therefore extensive 500kV additions were modeled, to include a second Pinal Central to Tortolita line, two Winchester to Vail lines and a Vail to South Loop to Pinal West line. Multiple 500/345kV transformers were required at the Winchester, Vail, South

Loop and Pinal West substations. Note that the Tortolita to Winchester 500kV line was modeled in the 2028 cases, and remained in the saturated load cases. These extensive 500kV system upgrades technically meet the SATS area load serving needs. However no analysis was performed to optimize the system or to determine if other options might have extended the life of the 345kV upgrades modeled at the 2028 load level.

22. Cochise County

22.1. Summary

A sub-committee of the SATS group was formed to address the transmission and load serving concerns specific to the Cochise County area. Of particular concern to this sub-committee was the transmission system serving loads in and surrounding the City of Sierra Vista. Although these concerns have been raised in prior transmission planning activities, a series of outages experienced in the Sierra Vista area, during the period of October 9th through October 11th of 2007, emphasized the need to formalize the discussions and try to find an acceptable solution. When an ACC Staff member characterized the issue as; "one that is very serious and needs to be dealt with ASAP,"[26] SATS responded by creating the Cochise County Study Group. Leadership of the Group was assigned to SSVEC. SWTC agreed to perform the technical studies associated with the Group's efforts.

Cochise County comprises the southeastern corner of Arizona and is bordered by New Mexico to the east and Mexico to the south. The major cities in this area include Benson, Bisbee, Douglas, Sierra Vista, Tombstone and Willcox. Adjacent to the City of Sierra Vista is Fort Huachuca, a major U.S. military installation. The sub-committee's study effort included the participation of representatives from each of the load serving entities and transmission service providers in Cochise County as well as a representative from Fort Huachuca.

Transmission service in Cochise County consists principally of radial lines which feed into the underlying sub-transmission system. SWTC provides transmission service to SSVEC's Sierra Vista area loads principally via two radial lines; a

[26] See page 12 of October 24, 2007 SATS meeting notes.

115kV line from Pantano to Kartchner substations and a 230kV line from Butterfield to San Rafael substations. Some additional capacity can be imported into the Sierra Vista area over SSVEC's 69kV sub-transmission system from their tie to SWTC's Apache substation. WESTERN provides transmission service to Arizona Public Service (APS) which then delivers power, via a radial 115kV transmission line from the Adams Tap substation to its Mural substation, to serve its loads in the south-central and far southeastern corner of Cochise County. TEP serves Fort Huachuca via a radial 138kV line which emanates from its Vail substation. An alternative path for up to approximately 16 MW to Fort Huachuca is provided by a TEP 46kV sub-transmission line connected to the TEP 138kV bus at the South Loop substation. Alternatives for supplemental emergency service are under consideration in this study. The issue presented for resolution to this subcommittee was that, under various load conditions, an outage of any one of these radial transmission lines (an N-1 condition) could result in the loss of load.

The subcommittee members held their meetings over the period of November, 2007 through January, 2008. The members of this subcommittee agreed that the objective of the study group would be:

To determine and recommend transmission solution(s) using 115, 138, and 230kV lines and substations to solve existing N-1 transmission problems within southern Cochise County.[27]

The study also considered and evaluated local area 69kV sub-transmission alternatives, as well as options to either interconnect or provide emergency ties among the radial transmission lines serving the load entities in Cochise County.

During this period SWTC conducted a technical evaluation on seven transmission options proposed by the subcommittee. These seven options, which included upgrades to both the area's transmission and sub-transmission systems, were:

- Pantano-Kartchner-San Rafael-Butterfield 230kV loop.

[27] See November 26, 2007 South of SATS meeting notes contained in Appendix E of this report.

- San Rafael to Mural 230kV Extension.
- Sloan to Huachuca East Radial 230kV.[28]
- Tie of TEP 138kV to SWTC 115kV Lines.
- Apache-Tombstone-Kartchner 115kV.
- Emergency Tie to TEP 138kV at Fort Huachuca.
- San Rafael to North Kartchner 230/115/69kV.

The technical results of these seven options are described in a subsequent section of this report titled "Description of Options Studied and Results." A significant amount of effort was committed to pursuing the goal of this subcommittee, especially by SWTC's technical staff. There was agreement by the subcommittee that a 230kV loop through the Sierra Vista area would be the preferred long-term technical solution. The future loop would not only eliminate reliability issues in the Sierra Vista area, but could also address future load serving issues for APS. What remained an issue within the subcommittee was the timing and economics of this 230kV loop. The group also agreed that it would be appropriate to wait for the results of a right-of-way study, commissioned by SWTC and which will include the Fort's concerns, before continuing their efforts. However, no final conclusion, beyond the need for a 230kV loop, was reached in this initial phase of the Group's study process. SSVEC supported the first of the seven transmission alternatives listed above. This option entailed upgrading the existing Pantano-Kartchner 115kV line to 230kV and connecting the Kartchner and San Rafael substations. This would create a 230kV loop into the Sierra Vista area allowing for continuity of service in the event of an outage of either circuit (N-1 contingency). SWTC supported building a third transmission line into the Sierra Vista area which would ultimately tie into the San Rafael Substation, forming a 230kV loop. Both APS and TEP felt that their respective existing transmission systems were sufficient to meet their load serving obligations in the study area for at least the next ten years.

22.2. Description of Companies and Transmission System

[28] Sloan is a surrogate for a tap of the Butterfield to Pantano 230kV transmission line and Huachuca is a surrogate for a new 230/69kV substation in the Sierra Vista area. SSVEC's position was that the southern terminus needed to be located within the Sierra Vista load pocket rather than potentially north of the Fort Huachuca military reservation.

APS, TEP and SSVEC are the three load serving entities within Cochise County. Transmission service into this area is provided by SWTC, TEP and WESTERN. Following is a description of each of these entities' respective service areas and transmission facilities. At the end of this section of the report is a map which illustrates the service territories and transmission system within the Cochise County Study area.

Arizona Public Service (APS)

APS' service territory, included in this study, covers the south-central and far southeastern portion of Cochise County. It includes the cities of Bisbee, Douglas, and Tombstone. Transmission service to this area consists of an APS owned radial 115kV line which connects at the Adams Tap switchyard to Western's Nogales-Apache 115kV line. The APS 115kV line connects to the Mural substation southeast of Bisbee at which the APS 69kV sub-transmission system provides service to its loads in the study area.

Southwest Transmission Cooperative (SWTC)

SWTC's main transmission facilities in Cochise County emanate from AEPCO's Apache generation facility located in north-central Cochise County. From the Apache facility SWTC's transmission lines go north to the Redtail substation, northwest to the Winchester substation and west to the Bicknell substation. Connected to SWTC's Apache-Bicknell 230kV line are three substations, two of which have radial transmission circuits which serve SSVEC's loads in the Sierra Vista area. These are the Butterfield-San Rafael 230kV line and the Pantano-Kartchner 115kV line. At both San Rafael and Kartchner are 100 MVA transformers that drop the voltage down to 69kV which then feed into the SSVEC 69kV sub-transmission system in the Sierra Vista area. The following map illustrates SWTC's transmission facilities serving the Sierra Vista area.

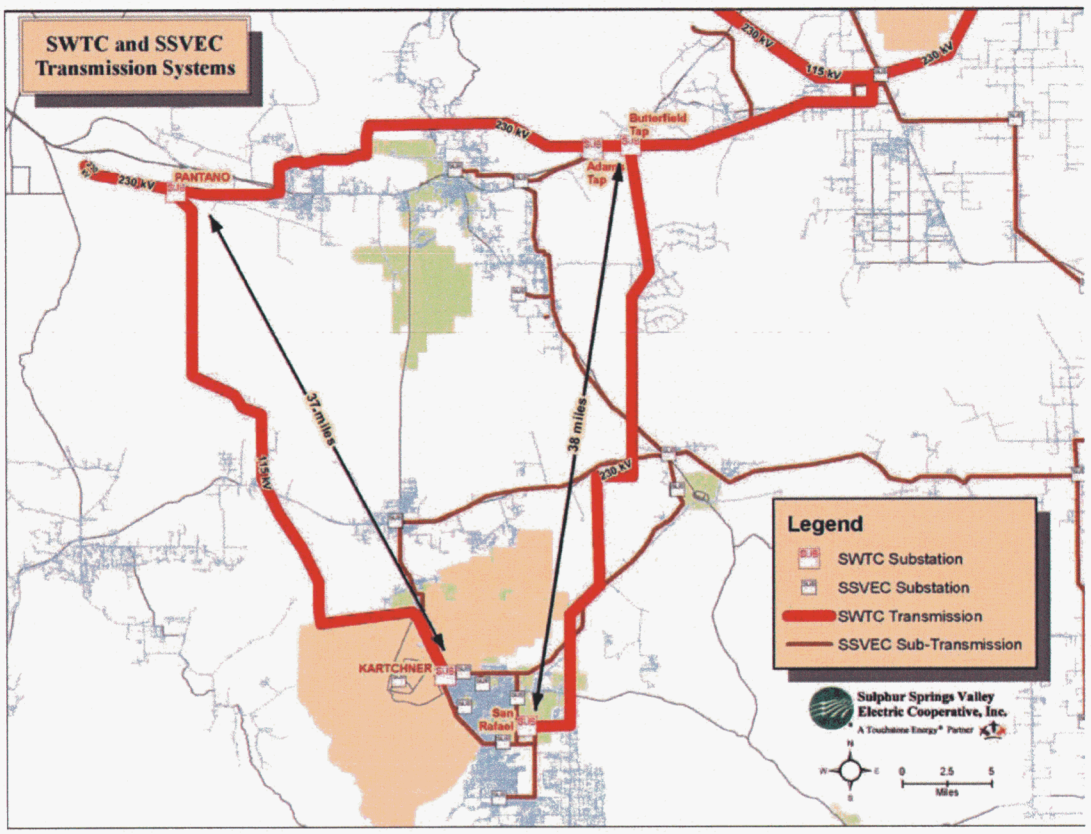


Figure 46. SWTC and SSVEC Transmission System

Sulphur Springs Valley Electric Cooperative (SSVEC)

SSVEC is the load serving entity for the majority of Cochise County. Its major loads in the County consist of the Sierra Vista area, at just over 100 MW, followed by the Benson area, at approximately 30 MW. Other communities served by SSVEC, in the study area, include Elfrida, Huachuca City, Patagonia, Sonoita, and Willcox. Transmission service into the Sierra Vista area consists of SWTC's Pantano-Kartchner 115kV and Butterfield-San Rafael 230kV transmission lines. From the Kartchner and San Rafael substations power is distributed throughout the Sierra Vista area via SSVEC's 69kV sub-transmission system. SSVEC's 69kV sub-transmission system is normally operated in an "open loop" configuration because its system was not designed to, nor can it withstand to, operate in a "closed loop" configuration other than for brief periods in response to emergency conditions.

Tucson Electric Power Company (TEP)

TEP's load serving obligation in Cochise County is limited to providing for Fort Huachuca's power requirements. Fort Huachuca is a major Army installation which borders the City of Sierra Vista to both the north and west. This facility is equivalent to a city of 15,000 and is one of the largest employers in Southern Arizona. The Fort's current peak demand is approximately 22 MW. The principal means of serving the Fort is via a 138kV line emanating from TEP's Vail substation. A 46kV line, which was the original means of supply, continues to be maintained by TEP and serves as a back-up to the 138kV line. This 46kV line has demonstrated the capability of supplying up to 16 MW of Fort load and may be capable of more. Provisions for additional back-up service through TEP's rights on the SWTC system may be implemented upon agreement of appropriate parties, according to the terms established in a Power Service Agreement and Letter Agreement between TEP and SWTC

Western Area Power Administration (WESTERN)

WESTERN is a Federal entity under the Department of Energy. Its Parker-Davis transmission system reaches throughout western, central and south-central Arizona. WESTERN's transmission system in the study area consists of a single 115kV line from its Nogales substation to the Apache substation. This 115kV line is the single source of transmission service to the APS service area in southeastern Cochise County.

Service Area Map

The following map illustrates the service areas and transmission system within Cochise County.

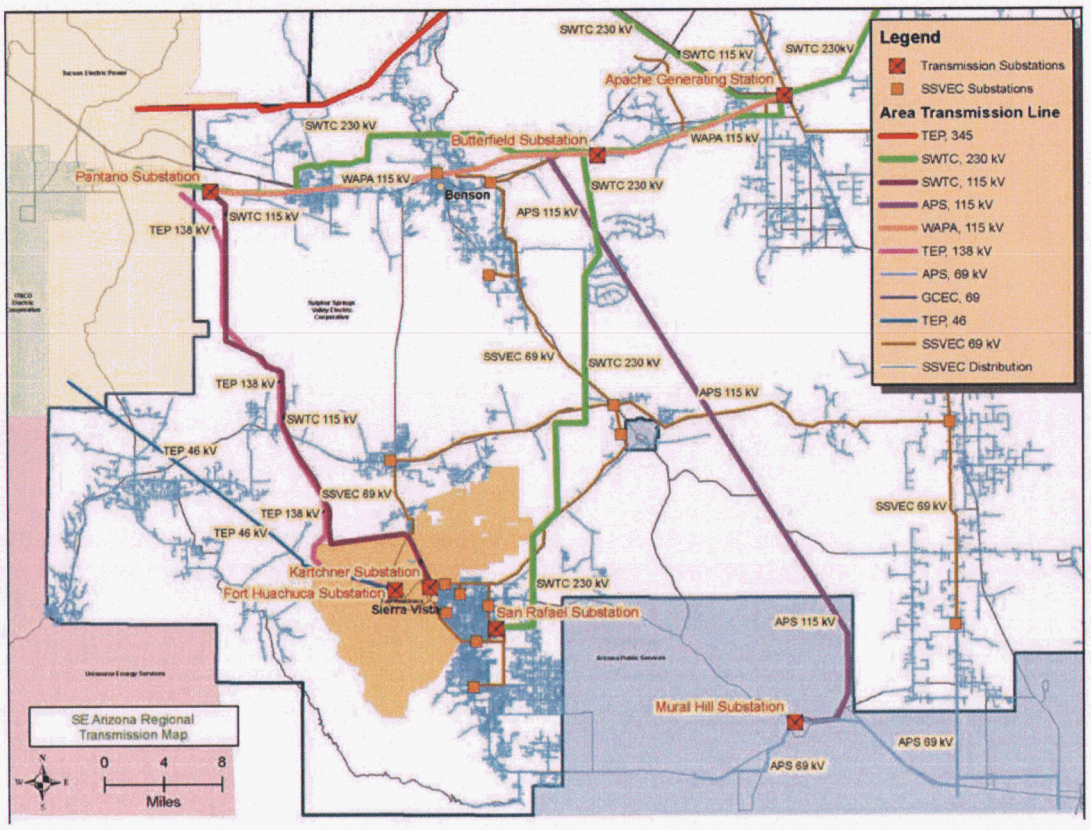


Figure 47. Cochise County Service area Map

22.3. Summary of Issues

The basis for creating the Cochise County study group was to address the issue of service reliability associated with loads served off of radial transmission lines. Although the County has multiple transmission lines feeding into the area, none of these lines are interconnected except via the underlying 69kV sub-transmission system. An outage of any one of these facilities normally results in the loss of load fed by that particular circuit. Each of the load serving entities must then invoke an emergency response in an effort to restore the affected service. Following is a brief description of the transmission issues faced by each of the three load serving entities in the County.

APS – In the event of an outage on the Adams Tap to Mural 115kV line APS will lose service to its loads in Cochise County. APS can restore service to its customers by turning on its Douglas generation and closing its 69kV emergency

tie with SSVEC at the McNeal substation. However, assuming there is available transmission capacity, closing this tie requires verbal communication and mutual agreement between the APS, SWTC, AEPCO, WESTERN and SSVEC operators. At present APS does not expect significant load growth in its Cochise County service area. Beyond pursuing a second emergency tie with SSVEC, just south of the Sierra Vista area near Palominas, APS believes that the current transmission system is sufficient to meet its load serving obligations in Cochise County. The only caveat to this position is if a significant spot-load should develop in the APS service area. Such an event would require an additional transmission connection in order to serve the total APS load in the study area.

SSVEC – An outage of either of the Pantano-Kartchner or Butterfield-San Rafael transmission lines will result in an immediate loss of service in the Sierra Vista area that may be restored by 69kV sub-transmission switching. It may not be possible to restore all loads during peak load times. Both the Pantano-Kartchner 115kV line and the Kartchner 115/69kV transformer are rated at 100 MVA. Under an outage of the Butterfield-San Rafael 230kV line the Pantano-Kartchner circuit is incapable of serving the Sierra Vista area loads for a portion of the year. This same condition exists under an outage of the Pantano-Kartchner line since the San Rafael 230/69kV transformer is also rated at 100 MVA. Under an N-1 of either transmission circuit service restoration to the Sierra Vista area entails SSVEC closing-in its normally open 69kV sub-transmission tie to its Tombstone Junction connection and possibly the need to close its emergency tie with APS at McNeal. This permits load to be fed from both the remaining transmission circuit and SSVEC's 69kV sub-transmission system. However, due to the intricacies of closing-in the 69kV sub-transmission system, principally due to voltage issues, this process can result in certain portions of the service area being without service for several hours.

TEP - An outage of the TEP 138kV line results in automatic throw-over of the Fort Huachuca facility to TEP's 46kV line. It is possible, depending on the level of the Fort's load, that brown out conditions may occur and/or some portion of the Fort's load may be curtailed until the 138kV line is brought back in service. The Fort's twenty year projection indicates virtually no growth in demand. Thus, increased system reliability as well as load serving capability are the primary concerns for

Fort Huachuca. To address this issue the Fort is pursuing an emergency tie with SSVEC. Although this tie will normally be operated as an open connection, under an outage of the 138kV line, and assuming the 46kV line cannot provide for Fort Huachuca's full load and that there is capacity on the SWTC and SSVEC system, closing the tie will permit TEP to supply the Fort's full load under emergency conditions. However, due to the need for operator intervention to close the emergency tie, a portion of the Fort load may be interrupted for some period of time. Closing this proposed tie will require verbal communication and mutual agreement between the TEP, SWTC, AEPCO, and SSVEC operators. Isolation of the Fort's critical loads that could be backed up by a combination of UPS and emergency generation have been discussed as a potential solution considering the relative lack of load growth.

22.4. Description of Options Studied and Results

Technical analysis was performed on seven transmission alternatives. These options included:

1. Pantano-Kartchner-San Rafael-Butterfield 230kV loop.
2. San Rafael to Mural 230kV Extension.
3. Sloan to Huachuca East Radial 230kV.
4. Tie of TEP 138kV to SWTC 115kV Lines.
5. Apache-Tombstone-Kartchner 115kV.
6. Emergency Tie to TEP 138kV at Fort Huachuca.
7. San Rafael to North Kartchner 230/115/69kV.

The technical analysis was performed by SWTC using the General Electric Positive Sequence Load Flow (PSLF) program. An approved 2016 Southeast Arizona Transmission Study (SATS) base case was used for the studies. All line and transformer outages that affected the SSVEC service area were evaluated, however only the major outages that produced issues in the Sierra Vista area are documented in this section of the report. Using the base case, the study also evaluated a load increase in the SSVEC's Sierra Vista service area of 10%, 20%, 30%, and 40% above the 2016 base load levels. The Fort's and APS' loads were not adjusted during this analysis. This was done in an effort to determine the implications of load growth on each of the proposed system modifications. The

following illustrates the varying load levels which are referenced in the subsequent option descriptions.

Load Levels:

*Sierra Vista area load forecast based on SSVEC 2005 substation data.

Base - 134.42 MW (projected 2016 base load)
10% - 147.86 MW (comparable to 2019-2020 projected load)
20% - 161.30 MW (comparable to 2022-2023 projected load)
30% - 174.75 MW (comparable to >2024 projected load)
40% - 188.19 MW (comparable to >2026 projected load)

A description of each option, along with the technical study results, is provided below. Note that the analysis was conducted under two scenarios - "Open Configuration" and "Closed Configuration". Following is the background to explain the rationale for these scenarios. SSVEC has 4 primary load centers which are the Sierra Vista, Benson, Elfrida, and the Willcox areas. These load centers are geographically spaced at the ends of an "X" that has legs 40 miles to the center of the "X" or 80 miles point to point. Within each load center, there is a SWTC delivery point [except Benson] from which SSVEC's 69kV sub-transmission system distributes the energy within the load center. Each of the legs of the "X" is a 60+ year old, small wire, 69kV sub-transmission line. At the center of the "X" SSVEC has its Tombstone Junction Switching Station. The "X" was the original 1940's to 1950's method of distributing power within Cochise County for those areas without local generation but which did have a need for electricity. Under today's loads, this "X" of a 69kV sub-transmission system cannot provide complete back-up from one end of the "X" to another.

All of SSVEC's 69kV sub-transmission, whether within the load center or as part of the "X", was designed, built, sectionalized, and therefore operated as radial lines or "open" configuration. The center of the "X", Tombstone Junction Switching Station, is normally opened in all directions except one to provide the switching station its needed station power. During emergency conditions, Tombstone Junction's breakers can be closed so that some amount of power can flow between the load centers. This creates a looped or "close" configuration. The looped configuration provides voltage support and very limited capacity from a

load center to another load center. The difficulty is that the sectionalizing [relaying, breaker location, number of breakers, etc] was not designed or built to operate as a loop. A fault on any part of the "X" during a looped configuration would likely cause a wide spread outage for most, if not all, load centers.

Option 1—Pantano-Kartchner-San Rafael 230kV Loop

Description of Project

This option would entail upgrading the existing Pantano to Kartchner 115kV line by installing a new 36 mile 1272 ACSR 230kV line from the Pantano Switchyard to tie to a new Kartchner 230/69kV transformer. The existing Kartchner 115/69kV transformer would be retired. A new 8.3 mile 1272 ACSR 230kV line would be constructed which would connect the existing San Rafael 230kV Substation to tie to the Kartchner Substation. The San Rafael Substation would be upgraded with another breaker to accommodate the new 230kV line to Kartchner.

Initial Results

- Studies determined that under a Butterfield to San Rafael outage there were few issues found regarding line loading and low voltages in the Sierra Vista area. Low voltages were present in the Benson/Wilcox section of the SSVEC loads under certain outages

More Results

- -Open Configuration-
  - **Base** No issues were seen in Sierra Vista
  - **10%** - Under a Kartchner 230/69kV transformer outage, line loading over 100% occurred on the Keating Jct.-Hawes 69kV line.
  - **20%** - Under a Kartchner 230/69kV transformer outage, line loading over 100% occurred on the Keating Jct.-Hawes, Hawes-Ramsey Tap1 and San Rafael-Ramsey Tap1 69kV lines.
  - **30%**- Under a Kartchner 230/69kV transformer outage, line loading over 100% occurred on the Kartchner-Keating Jct., Keating Jct.-Hawes, Hawes-Ramsey Tap1 and San Rafael-Ramsey Tap1 69kV lines. Low voltage (~0.88 p.u) is present at the Sonoita Bus.
  - **40%**- Under a Kartchner 230/69kV transformer outage, line loading over 100% occurred on the Kartchner-Sierra Vista, Kartchner-Keating Jct.,

Keating Jct.-Hawes, Hawes-Ramsey Tap1 and San Rafael-Ramsey Tap1 69kV lines. The Kartchner-Sierra Vista 69kV line loads under the Butterfield-San Rafael, Apache-Butterfield and Apache-Red Tail 230kV outages. Low voltages (~.88 p.u.) was present at the Sonoita, Huachuca East and Huachuca West 69kV buses.

- -Closed Configuration-
  - **Base – 30%-** Under certain outages within the Sierra Vista area, line loading over 100% occurred on the Kartchner-Sierra Vista, Sierra Vista-Bella Vista, and Bella Vista-Charleston 69kV lines. Low voltages (~0.85 p.u.) is present at Sonoita, Huachuca East and Huachuca West 69kV lines.
  - **40%-** Under N-0, low voltages exist in the Benson/Southeast area. Under a Butterfield-San Rafael outage case will not solve due to severely low voltages.

Option 2 – San Rafael to Mural 230kV Extension

Description of Project

This option was studied as an augmentation to Option 1. The intent is to study the increase in load serving capability associated with a 230kV extension into the APS service area. It assumes that the 230kV loop is in place. In addition, this option assumes installation of a new 32 mile, 1272 ACSR 230kV line from the San Rafael Substation to tie to the existing APS Mural Substation. San Rafael Substation would be upgraded with another breaker to accommodate the new 230kV line. The APS Mural 115/69kV substation would be upgraded to accommodate the 230kV line from San Rafael.

Initial Results

- Studies determined that under an outage of the Butterfield to San Rafael 230kV lines there were few issues found regarding line loading and low voltages within the Sierra Vista area. Low voltages were found in the Benson/Wilcox section of the SSVEC service area under certain outages. Results of this study are similar to those of the San Rafael to Kartchner to Pantano 230kV loop.

Option 3--Sloan to Huachuca East Radial 230kV Line

Description of Project

This option entailed installation of a new 24 mile, 1272 ACSR 230kV line from the proposed Sloan Substation to tie to the existing Huachuca East 69kV Substation. The existing Huachuca East Substation would be upgraded to include a new 230/69kV transformer to be served out of a new 230kV bay position.

Initial Results

- Studies determined that under an outage of the Butterfield to San Rafael 230kV line that few issues were found regarding line loading and low voltages within the Sierra Vista area. Low voltages were found in the Benson/Wilcox section of the SSVEC service area under certain outages.

More Results

- -Open Configuration-
  - **BASE, 10%, 20% & 30%-** Issues found in the Sierra Vista area were line loadings of over 100% of the emergency rating on the Kartchner to Keating Jct. 69kV line and the Kartchner/Sonoita/Huachuca East 69kV lines. Low voltage of ~0.8 p.u. was found at the Kartchner 115kV bus.
  - **40%-**Line loading exists at Huachuca Jct.-Huachuca East. Low voltages of ~0.75-0.8 p.u. were present at several Sierra Vista area buses. At this load level SWTC/SSVEC would suggest a larger capacitor bank under the open configuration.

- Closed Configuration-
  - **BASE-** Line load over 100% of emergency rating occurred at the Sonoita-Huachuca East and Kartchner-Sierra Vista 69kV lines.
  - **10%-** Line loadings over 100% of emergency rating occurred at the Kartchner-Sonoita, Sonoita-Huachuca East, Kartchner-Sierra Vista and Sierra Vista-Bella Vista 69kV lines.
  - **20%-** Line loadings over 100% of emergency rating occurred at the Kartchner-Sonoita, Sonoita-Huachuca East, Kartchner-Sierra Vista and Sierra Vista-Bella Vista 69kV lines. Low voltage of ~0.8 p.u. was present at the Kartchner 115kV bus.
  - **30%**-Line loadings over 100% of emergency rating occurred at the

Kartchner-Sonoita, Sonoita-Huachuca East, Kartchner-Sierra Vista and Sierra Vista-Bella Vista 69kV lines. Low voltages of ~0.8 p.u. were present at five Sierra Vista area buses.

- **40%-** Line loadings over 100% of emergency rating occurred at the Kartchner-Sonoita, Sonoita-Huachuca East, Kartchner-Sierra Vista, Sierra Vista-Bella Vista and Keating Jct.-Hawes 69kV lines. Low voltages of ~0.8 p.u. were present at several Sierra Vista area buses. An additional capacitor bank at San Rafael would help raise the voltages at some surrounding buses and alleviate line loading on the Keating Jct.-Hawes 69kV line.

Option 4—Tie of TEP 138kV to SWTC 115kV Lines

Description of Project

The TEP Vail to Ft. Huachuca 138kV line and the SWTC Pantano to Kartchner 115kV line share a common corridor until they reach a point just north of Fort Huachuca. At this point of divergence the two lines would be tied via a new 138/115kV substation containing a 138/115kV 100/133/167 MVA transformer. A three breaker-ring bus 138kV configuration would be built to loop in the Vail to Ft. Huachuca line as well as accommodate a 138/115kV transformer. Another three breaker-ring bus would be built on the 115kV side to loop in the Pantano to Kartchner 115kV line as well as to accommodate a 115kV line to the 138kV switchyard.

Under this TEP/SWTC tie configuration various lines within the Sierra Vista service area would remain open in order to restrict any flow from entering Santa Cruz County. This arrangement is intended to mitigate concerns related to TEP's "2 county bonds." In this study it was assumed that under the Butterfield to San Rafael 230kV line outage, these normally open lines would be closed. An initial look only considered impacts on the SSVEC system. The TEP system buses in the Ft. Huachuca area were monitored during the contingency analysis and no adverse impacts were found. Once more consideration is given to the emergency tie additional study work will be done to assess the impacts of certain outages on both the TEP and SSVEC systems.

Results

- -Open Configuration-
  - None of the cases would solve for a Butterfield to San Rafael 230kV line outage.
- -Closed Configuration-
  - **BASE-** Line loadings over 100% occurred at Kartchner-Sierra Vista 69kV line and at the Kartchner 115/69kV transformer. Low voltage of ~0.85 p.u. was present at the Kartchner 115kV bus.
  - **10%-** Line loadings over 100% occurred at Kartchner-Sierra Vista, Sierra Vista-Bella Vista 69kV lines and at the Kartchner 115/69kV transformer. Low voltage of ~0.8 p.u. was present at the Kartchner 115kV bus.
  - **20%-** Line loadings over 100% occurred at Kartchner-Sierra Vista, Sierra Vista-Bella Vista 69kV lines and at the Kartchner 115/69kV transformer. Low voltages of ~0.7 p.u. were present at all Sierra Vista area buses.
  - **30% & 40%-** Case would not solve due to severely low voltages of 0.6 & 0.7 p.u. within the Sierra Vista area. With the addition of a second capacitor bank at San Rafael, the possibility of raising some of the bus voltages is possible but would still be below the WECC/NERC standards.

Option 5—Apache-Tombstone-Kartchner 115kV Line

Description of Project

A new 115kV line would double circuit with various segments of SSVEC's existing 69kV sub-transmission system. A 42.5 mile run from Apache Substation to Tombstone Junction would consist of six segments (Apache/ Cochise/ Johnson Jct/ Mescal/Benson/ David Jct/ Tombstone Jct.). The additional 21.1 mile run from Tombstone Junction to Kartchner would consist of five segments (Tombstone Jct/ Tombstone/ Charleston/ Bella Vista/ Sierra Vista/ Kartchner). By creating this loop it would allow for SSVEC to upgrade their 69kV system as well as having a loop within the SSVEC service territory.

Initial Results

- During a Butterfield to San Rafael 230kV line outage the program would not solve under an islanded configuration for any of the cases studied.

More Results

- -Closed Configuration-
  - **Base-** Line loadings of over 100% of the emergency rating on the Kartchner-Sierra Vista and Sierra Vista-Bella Vista 69kV lines.
  - **10%-** Line loading of over 100% of the emergency rating on the Kartchner 115/69kV transformer and the Kartchner-Sierra Vista and Sierra Vista-Bella Vista 69kV lines. Low voltage of ~0.89 p.u. was present at the Kartchner 115kV line.
  - **20%-** Line loading of over 100% of the emergency rating on the Kartchner 115/69kV transformer and the Kartchner-Sierra Vista and Sierra Vista-Bella Vista 69kV lines. Low voltage of ~0.80 p.u. was present at all Sierra Vista area buses. (*assumption- two capacitors 14.4 & 18.0 MVAR)
  - **30%&40%-** Case would not solve due to severely low voltages.

Option 6--Emergency Tie (EMTIE) to TEP 138kV at Fort Huachuca

Description of Project

The option entails building a new 138kV yard named EMTIE_2 substation looping in the Vail to Ft. Huachuca 138kV line at Fort Huachuca. From the EMTIE substation a new 2.3 mile, 795 ACSR, 138kV line will run to SSVEC's Buffalo Soldier Substation. This tie would normally be operated in an open condition and only closed in response to a system emergency.

Initial Results

- It is recognized that this option will not solve major issues beyond the 2016 timeframe. It had been identified that the combination of this emergency tie with TEP, in combination with the emergency tie with APS, will allow SSVEC to restore service to portions of their Sierra Vista loads under an outage of the Butterfield-San Rafael 230kV line.

More Results

- Case utilizes closed configuration of system. APS emergency tie is placed in service along with TEP emergency tie.
  - **BASE-** Line loading of over 100% of the emergency rating was present at the Kartchner-Sierra Vista 69kV line.
  - **10%-** It was assumed that a 14.4 & 18.0 MVAR capacitor was placed at the San Rafael 69kV bus. Line loading of over 100% of the emergency

rating was found at Kartchner-Sierra Vista and Sierra Vista-Bella Vista 69kV lines. Low voltages of ~.80 p.u. were present at all Sierra Vista area buses.

- **>20%**- At a 20%, 30% and 40% load increase, in the Sierra Vista area the case would not solve.

Option 7—San Rafael to North Kartchner 230/115/69kV

Description of Project

This option entails construction of a new 230kV line from the existing San Rafael Substation to a new North Kartchner Substation which would be adjacent to the existing Kartchner Substation. The Kartchner and North Kartchner substations would be connected via a new 0.5 mile 1272 ACSR 115kV line. A 230/115/69kV transformer will be installed at North Kartchner. From North Kartchner a new 1.3 mile 69kV line will tie to the existing Sierra Vista Substation.

Initial Results

- This option includes a line upgrade of approximately 55.4 miles of SSVEC 69kV line from Apache to Sierra Vista.
- During a Butterfield to San Rafael 230kV line outage, the program will not solve under an islanded configuration for any of the cases studied. It has been identified that the emergency ties with APS at McNeal and Palominas will allow SSVEC to maintain continued service to portions of their Sierra Vista loads.

More Results

- Case utilizes closed configuration of system. APS emergency ties at McNeal and Palominas are placed in service. Two capacitor banks of 19.2 MVAR were placed at the San Rafael 69kV bus.
  - **BASE-** No issues seen in the Sierra Vista area however a recommendation for the Tap settings at the Pantano 230/115kV transformer be adjusted to accommodate this outage.
  - **10%-** There were no line loadings present for this outage. Low voltages of ~.85 p.u. were present at the Kartchner buses and at Sonoita. A recommendation for the Tap settings at the Pantano 230/115kV transformer to be adjusted to accommodate this outage.

- **>20-40%**- At a 20%, 30% and 40% load increase, in the Sierra Vista area the case would not solve.

22.5. Recommendation

The Cochise County Study Group agreed that an additional 230kV transmission line into the Sierra Vista area would be necessary to address system reliability and provide for expected future load growth. There was also agreement by the subcommittee that a 230kV loop through the Sierra Vista area is the preferred long-term technical solution[29]. The future loop would not only eliminate reliability issues in the Sierra Vista area, but could also address future load serving issues for APS. What remained an issue within the subcommittee was the timing of this 230kV loop. However, no final conclusion, beyond the need for a 230kV loop, was reached in this initial phase of the Group's study process.

The recommendation of the Cochise County Study Group was to suspend its activities until the completion of a right-of-way study to be commissioned by SWTC. This study is intended to determine the probability of creating a new transmission corridor into the Sierra Vista area.

23. Sensitivity Analysis

Sensitivity analysis was conducted using a 2015 base case that was based on the 2018 case that evolved from the saturated load study. This case included an increased rating for the Apache – Butterfield 230kV line plus loop-in of the 115kV WESTERN line at Pantano. These projects effectively increased the line rating from Apache to Pantano. Hence the need for a project to mitigate post-contingency overloads on the 230kV lines was deferred to the 2014 time frame without the need to trip the Bowie generator or the Bicknell transformer. This configuration also enhances the ability of additional generation within the TEP load pocket to defer the next EHV project. The purpose of the sensitivity analysis was to obtain a sense of the impact of local Tucson generation on need and timing for proposed EHV projects discussed in this report.

[29] This agreement assumes that an initial looped and/or emergency tie utilizing the capability of existing local area transmission could be implemented as the first step. Provisions would be made to preserve the ability to install or upgrade existing facilities as load in the Sierra Vista area grows to the extent that 230kV infrastructure may be justified.

Table 24 indicates that addition of 150 MW of generation at the Irvington location effectively reduces the net load to be served from external resources that are imported by EHV transmission. Load Serving Capability (LSC) increases by a significant margin in excess of the amount of generation added within the TEP load pocket.

Generation @ Irvington Assumed Projects	Year	Pre-Project LSC (MW)	Post-Project LSC (MW)	Incremental LSC (MW)
Pinal Central - Tortolita	2011	2490	2750	260
150 MW at Irvington	2014	2750	3100	350
2nd 150 MW at Irvington	2018	3100	3200	100
Next Project Needed	2018	3200		

Table 24. Sensitivity to 300 MW Generation Added at Irvington 138kV

The net effect is that investment in EHV transmission may be deferred by four years, assuming the January 2008 load forecast. The second 150 MW increment of generation does not further increase LSC significantly. Deferral of EHV by addition of such generation is much less effective if the 230kV projects (e.g. Apache – Butterfield Reconductor and Pantano loop-in) are not included in the case. To explain, these specific 230kV projects increase the rating of the 230kV line from Apache to Pantano. This increase is important because controlled load shed in response to Category C contingencies within the TEP system continues to be effective at reducing post-contingency flows on the Apache to Pantano segment of the SWTC 230kV system up to the load level forecasted for the 2013 time frame. Increasing local generation extends the effectiveness of load shed by reducing net load within the TEP load pocket.

Otherwise, assuming the existing 230kV facility ratings, load shed cannot reduce post-contingency 230kV flows below the emergency rating for the same contingencies prior to 2013. Moreover, reducing net load by approximately 300 MW has not been demonstrated to be sufficient to make load shed effective.

The second sensitivity case which divides the new generation between Irvington and the DMP substation site appears to more effectively balance the reduction of imports between Vail and Tortolita. The result is that addition of approximately 300 MW of generation is more effective if divided within the TEP 138kV system. Table 25 shows that addition of the same amount of generation increases LSC by approximately 100

MW more than generation concentrated at Irvington.

Generation @ DMP & Irvington Assumed Projects	Year	Pre-Project LSC (MW)	Post-Project LSC (MW)	Incremental LSC (MW)
Pinal Central - Tortolita	2011	2490	2750	260
155 MW at DMP & 150 MW at Irvington	2014	2750	3300	550
Next Project Needed	2021	3300		

Table 25. Sensitivity to 155 MW Generation Added at DMP Plus 150 MW Added at Irvington 138kV

Generally, the sensitivity analysis indicates that addition of new generation within the TEP local area network may provide flexibility in making decisions related to EHV transmission system investments.

24. Economic Analysis

Economic Analysis consisted of alternative projects capital cost estimates that were prepared individually by the SATS Transmission Providers. However, the Transmission Providers decided to not disclose these preliminary estimates due to sensitivity over uncertainty associated with land and environmental costs as well as concerns that this information might influence actual land costs. Therefore the SATS 2009 Study Plan will include tasks to work with other subregional and regional planning entities in the Western Interconnection to arrive at cost estimates that are consistent throughout the west.

25. Developing a Flexible Plan

A flexible plan has built-in features that take uncertainty about future events into account. For example, Strategy A may ultimately offer the greatest load serving capability. However, it requires the most new 345kV facility construction to implement at a relatively higher cost, and possibly also has the greatest risk associated with obtaining the permits to build. There may be further financial risk of potential stranded investment if projected load growth fails to materialize, or if the actual growth rate is significantly lower than currently forecasted. The uncertainties that may influence thinking about which strategy to pursue are illustrated in the following Figure 48: Example Decision Influence Diagram.

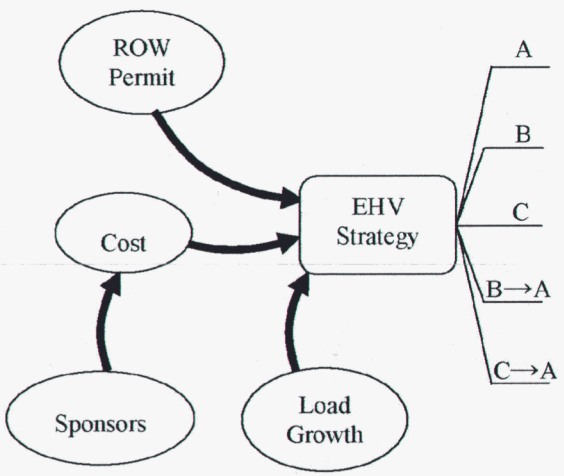


Figure 48. Example Decision Influence Diagram

Thinking about these uncertainties leads to the addition of variations to the basic strategies to attempt to mitigate regulatory and financial risks. For instance, Strategy B may be modified to preserve the option of switching to Strategy A by acquiring ROW or obtaining options on the rights-of-way needed to add the 345kV lines that would not otherwise be necessary in Strategy B. Modifications would also be considered for the Strategy B local area HV transmission plan, again to preserve the option to make the switch to Strategy A. This option is referred to as "B→A" in the above influence diagram.

An example of a possible plan is shown in Figure 49: Sample Flexible Plan Decision Tree. The decision on the left side is to embark upon a plan to build only those components that are common to each of the strategies in the near term. For example, following the upper branch of the tree, the next EHV project would be the Vail – East Loop 345kV line, with the associated 138kV upgrades as required to implement Vail – East Loop. As load increases and need for the next EHV reinforcement is established, a decision may be made to build Tortolita – North Loop, and additional 138kV complementary improvements. At this point, only one common project remains and the decision is when to implement. Eventually, as the future unfolds, decision makers will have more information, such as high growth has occurred and Strategy A must be implemented. On the other hand, growth has been sluggish and Strategy B or C may be appropriate.

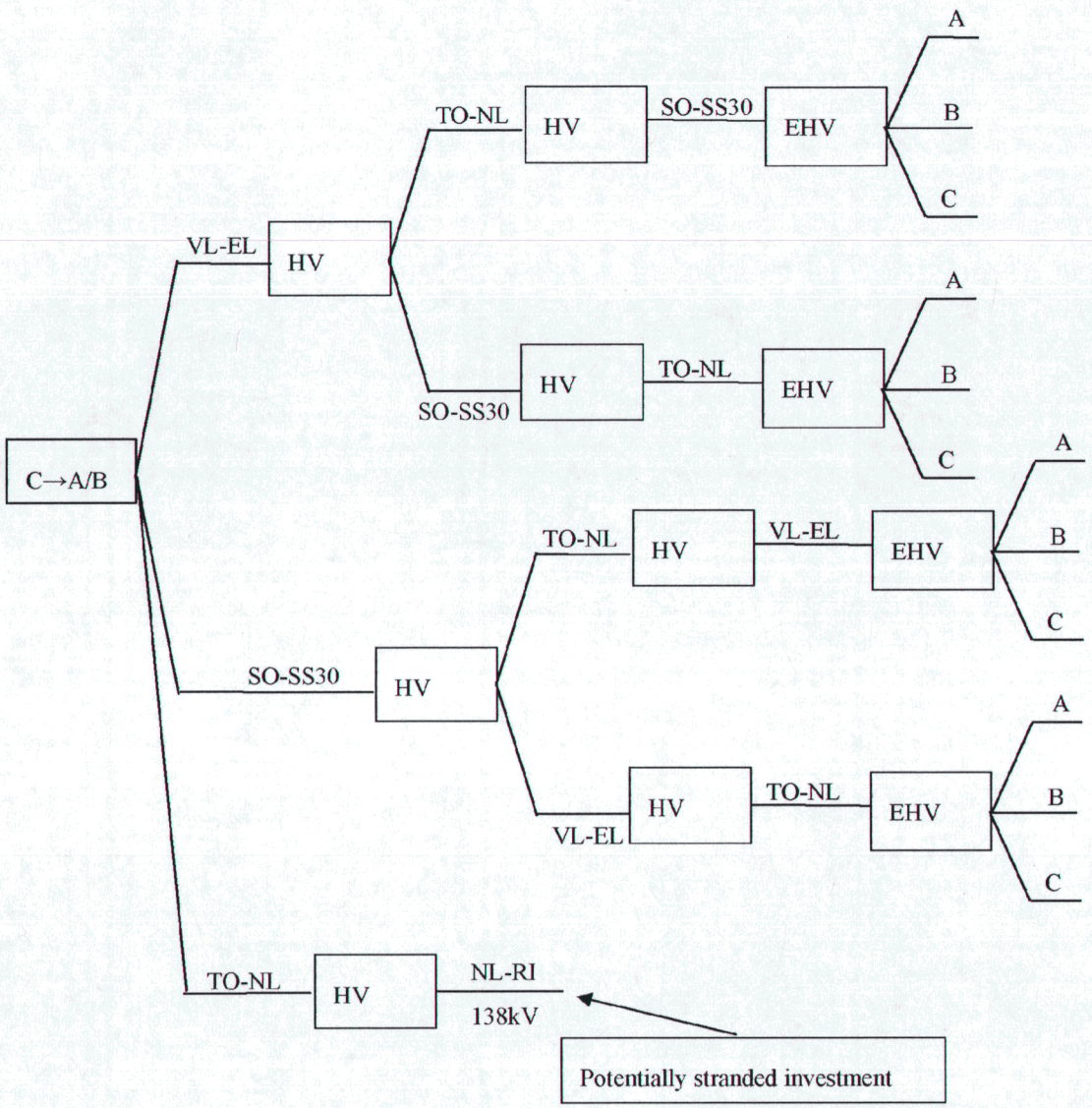


Figure 49. Sample Flexible Plan Decision Tree

Strategy C (or Strategy F may be substituted for Strategy C) may be similarly modified to ensure flexibility to change strategy in the event load growth is higher than expected, sponsors become interested in joint participation such that the financial risks are reduced, or other factors change. This strategy is represented as "C→A", and modification to the basic Strategy C would entail measures similar to B, but tailored to

those specific circumstances.

Additional cost, in excess of the basic Strategies A, B and C cost would be incurred in either case. The amount of incremental investment required to gain flexibility depends on each transmission providers' risk tolerance and their respective views of the future.

26. List of Projects for Ten Year Planning Horizon

The projects listed in the following tables are preliminary estimates only. All projects and their respective schedules are subject to change based on more detailed and more current analyses to be performed for five year capital budgets and subsequent ten year plans. Note that some projects will be listed in the ten year and twenty year planning horizons to account for uncertainty of projects that may or may not be completed within ten years.

More analysis to be conducted according to the 2009 SATS Study Plan will also likely result in significant changes as discussed in this report.

EHV Projects – Ten Year Planning Horizon	
500kV Projects	**Comments**
Tortolita Transformer No. 3	2011
Pinal West – Pinal Central[30]	2012 – Joint Project Deferral Possible
Pinal Central - Tortolita	2012 – Joint Project Deferral Possible
345kV Projects	**Comments**
Vail 345/138kV Transformer No. 3	2012
Bicknell 345/230kV Transformer Replacement	2012
Greenlee 345/230kV Transformer 2	2012
Winchester – Vail Double Circuit	2014 - Possible Joint Project Deferral Possible or Substitution
Willow - Winchester	2014 - Possible Joint Project Deferral Possible or Substitution
Vail 345/138kV Transformer 4	2014
Irvington 345/138kV Transformer	2018 – Deferral Possible
Vail – Irvington	2018 – Deferral Possible
South Loop - Irvington	2018 – Deferral Possible
Vail – South Loop – Bicknell (loop-in)	TBD - Possible Joint Project

Table 26. EHV Projects – Ten Year Planning Horizon

Tortolita Transformer No. 3: Included in preliminary TEP 2009-13 capital budget.

Pinal West – Pinal Central 500 kV Line: Joint project involving several participants. To be included in SWTC's 2011-2013 Construction Work Plan (CWP).

Pinal Central - Tortolita 500kV Line: Included in preliminary TEP 2009-13 capital budget.

Vail 345/138kV Transformer No. 3: Included in preliminary TEP 2009-13 capital budget.

[30] Southeast Valley Project participants are investigating deferral of the project from 2012 to 2013 due to the significant reduction in economic expansion as of November 2008.

The need for this project is subject to further analysis.

Bicknell 345/230 kV Transformer Replacement: Replaces the existing 90/120/150/193 MVA unit with a 225/300/420 MVA unit. To be included in SWTC's 2011-2013 CWP.

Greenlee 345/230 kV Transformer 2: The existing 90/120/150/193 MVA unit that is being replaced at Bicknell will be moved to Greenlee. To be included in SWTC's 2011-2013 CWP.

Winchester – Vail Double Circuit: Refer to Section 15.1 Greenlee to Vail EHV and 230kV Corridor Area and Section 23 Sensitivity Analysis for a description of conditions necessitating this project, and for a discussion of alternatives that may defer or be substituted for this project.

Willow – Winchester: Same comment as for the Winchester – Vail Double Circuit project.

Vail 345/138kV Transformer 4: The need for this project is subject to further analysis.

Irvington 345/138kV Transformer, Vail – Irvington and South Loop – Irvington: Refer to Section 15 Characteristics of SATS Transmission System and Section 23 Sensitivity Analysis and Section for factors that may influence the choice and/or sequencing of this project.

Vail – South Loop – Bicknell (loop-in): Refer to Section 15.2 South of Tucson Area for a description of area characteristics, possible alternative solutions and a preliminary plan for study.

230kV Projects – Ten Year Planning Horizon	
230kV Projects	**Comments**
Pantano to Sahuarita 230 kV Line Loop-in to New Tucson	2010
San Rafael 230/69kV Transformer 2	2011
Pinal Central 230/115kV Transformer	2013 – Joint Project
Apache - Butterfield	2014
Butterfield - Bicknell	2015 – Deferral Possible
Pantano – Kartchner	2018 – Deferral Possible
Kartchner – CS2	2018 – Deferral Possible
San Rafael – CS2	2018 – Deferral Possible

Table 27. 230kV Projects – Ten Year Planning Horizon

Pantano to Sahuarita 230 kV Line Loop-in to New Tucson: Loop the Pantano to Sahuarita 230 kV Line into a new SWTC New Tucson Substation. Included in SWTC's 2009-2010 CWP.

San Rafael 230/69kV Transformer 2: See section 22 Cochise County for more details. Add second 230/69kV transformer at San Rafael. To be included in SWTC's 2011-2013 CWP.

Pinal Central 230/115 kV Transformer: Add a 230/115 kV transformer at Pinal Central. Joint project involving several participants. To be included in SWTC's 2011-2013 CWP.

Apache – Butterfield 230kV Line: Upgrade the existing 795 ACSR line to one with higher capacity. The line capacity needed is being determined with additional analysis. This is the first of the 230kV lines from Apache to Bicknell that were identified in the SATS study needing upgrade. To be included in a future SWTC CWP.

Butterfield - Bicknell 230kV Line: Upgrade the existing 795 ACSR line to one with higher capacity. The line capacity needed is being determined with additional analysis. This was the second of the 230kV lines from Apache to Bicknell that were identified in the SATS study needing upgrade. To be included in a future SWTC CWP.

Pantano – Kartchner 230kV Line: See section 22 Cochise county for more details. This line and related substation construction have ongoing investigation into what can be built. Possibilities include a new 230 kV line being built or a rebuild of the existing Pantano – Kartchner 115 kV line. To be included in a future SWTC CWP.

Kartchner – CS2 230kV Line: See section 22 Cochise County for more details. This line and related substation construction have ongoing investigation into what can be built. To be included in a future SWTC CWP.

San Rafael – CS2 230kV Line: See section 22 Cochise County for more details. This line and related substation construction have ongoing investigation into what can be built. To be included in a future SWTC CWP.

138kV Projects – Ten Year Planning Horizon	
138kV Line Projects	**Comments**
22nd – East Loop New Line	2009
Tortolita – North Loop Quad	2010
North Loop – Rillito Reconductor	2012
Vail – Irvington 1 Reconductor	2010
Vail – Irvington 2 Reconductor	2010
DMP – Tucson New Line	2010
DMP – Northeast Uprate	2010
Cienega Double Circuit Tap New Line	2010
Vail – Los Reales Uprate	2010
Los Reales – Pantano Uprate	2011
Pantano – East Loop Uprate	2012
Canoa Ranch – Duval CLEAR New Line	2012
Rillito – Northeast Uprate	2012
Irvington – Tucson New Line	2013
Vail - Valencia 138kV Conversion	2013
North Loop – West Ina Reconductor	2014
North Loop – DMP Reconductor	2014
South Loop – Irvington Reconductor	2018
South Loop – Midvale Reconductor	2018

Table 28. 138kV Projects – Ten Year Planning Horizon

22nd – East Loop New Line: Included in preliminary 2009-13 capital budget. Capacity upgrade replaces the existing circuit with pole-line upgrade from 477 ACSS to 954 ACSS.

Tortolita – North Loop Quad: Included in preliminary 2009-13 capital budget. This project rebuilds three existing 138kV circuits between the Tortolita and North Loop substations to increase capacity through the use of 954 ACSS conductor and to accommodate a 115kV circuit for SWTC.

North Loop – Rillito Reconductor: Included in preliminary 2009-13 capital budget. Schedule is subject to revision. This project is to increase capacity to mitigate

contingency overload by upgrading the existing 795 ACSR with advanced conductor technology of similar mechanical, but increased thermal, characteristics that allows use of existing tower structures. This is the first phase of a plan to reconductor all three circuits on the triple circuit structure line between North Loop to West Ina. Completion of the North Loop to Rillito phase will help to provide continuity while the next phase requiring outage of the two remaining circuits.

Vail – Irvington 1 and 2 Reconductor: This project to be done in phases. Phase 1 is to remove clearance issues to allow operation at higher temperatures; therefore, achieving a higher rating. Phase 2 consists of reconductoring using advanced conductor technology that allows use of existing tower structures when it is needed for load growth.

DMP – Tucson New Line: Included in preliminary 2009-13 capital budget. This project provides an update to 138kV of an existing 46kV tie between the DMP and Tucson stations to improve voltage stability during contingency conditions.

DMP – Northeast Rating Increase: Included in preliminary 2009-13 capital budget. Schedule is subject to revision. Increases circuit rating as part of a pole replacement project for this line. Substation terminal upgrade at the Northeast substation is required as well.

Cienega Double Circuit Tap New Line: Extends the existing Vail – Spanish Trail line to serve the new load serving Cienega substation. This project involves reconfiguration of circuits on the right-of-way connecting Vail to Fort Huachuca,. The segment to Spanish Trail includes approximately 3 miles of new single-circuit 138kV pole line and extension of 0.7 miles of new double-circuit 138kV pole-line to the Cienega station.

Vail – Los Reales – Pantano – East Loop Rating Increase: This project and schedule are subject to revision. The project increases clearance to allow conductor operation at higher temperature and hence higher rating.

Canoa Ranch – Duval CLEAR New Line: Included in preliminary 2009-13 capital budget. Increases load serving capability and continuity of service in the Green Valley area. The project extends the South-Green Valley-Canoa Ranch circuit through a

renovated substation on the FMI Sierrita Mine site. Here the circuit ties to another existing 138kV circuit out of South substation.

Rillito – Northeast Rating Increase: Project and schedule are subject to revision. This project mitigates contingency overloads of this 138kV circuit by upgrading the existing 795 ACSR with advanced conductor technology of similar mechanical, but increased thermal, characteristics that allows use of the existing tower structures.

Irvington – Tucson New Line: Project and schedule are subject to revision. This project consists of a new 138kV single-circuit pole-line on new right-of-way. The project mitigates contingency overloads of existing 138kV circuits out of the Irvington substation and anticipates construction of a new load serving substation in the vicinity of Kino Parkway southeast of the existing Santa Cruz substation.

Vail-Valencia 138kV Conversion: Included in preliminary 2009-13 capital budget. This project increases load serving capability in the UNSE-Santa Cruz district by relocating the source from WESTERN's Nogales 115kV switching station to the TEP Vail 345/138kV substation. A new 138kV circuit will be extended from Vail to the vicinity of the Nogales substation where it will tie into the existing pole-line to Nogales. The existing line that extends south to the Valencia substation in Nogales, AZ will be upgraded from 115kV to 138kV. All existing 115kV substations will be upgraded to 138kV to accommodate the new primary voltage.

North Loop – West Ina and North Loop – DMP Reconductor: Under consideration for post-five year capital budget. Both projects are to be done at the same time as described in the "North Loop – Rillito Reconductor Project" because they are on triple-circuit structures. Having increased capacity on the North Loop – Rillito line is needed to allow the remaining North Loop to West Ina and DMP circuits to be reconductored. The capacity increase for both circuits is needed to mitigate contingency overloads. This project consists of replacing the existing 795 ACSR with advanced conductor technology of similar mechanical, but increased thermal, characteristics that allows use of existing tower structures.

South Loop – Irvington and South Loop – Midvale Reconductor: Project and schedule are subject to revision. The capacity increase is needed to mitigate contingency

overloads. The project consists of upgrade of existing 795 ACSR with advanced conductor technology of similar mechanical, but increased thermal, characteristics that allows use of existing tower structures.

115kV Projects – Ten Year Planning Horizon	
115kV Line Projects	**Comments**
Saguaro – Adonis	2010
Adonis – Rattlesnake	2010
CAP system loop into Sandario	2010
CAP system loop into San Joaquin	2010
Valencia – Black Mountain	2010
Marana – Avra Valley	2010
Apache – Hayden loop into San Manuel	2010
Avra Valley – Sandario Tap	2011
Sandario Tap – Three Points	2011
Marana Tap – Marana	2012
Pinal Central – ED2	2013 – Joint Project
Saguaro to Adonis 115 kV Line Loop-in to Naviska	2015 – Deferral Possible
CAP system loop into Picture Rocks	2018 – Deferral Possible

Table 29. 115kV Projects – Ten Year Planning Horizon

Saguaro – Adonis 115kV Line: A part of constructing a new 115 kV line from Saguaro to Rattlesnake (joint project with CAP) that includes the addition of a new substation, Adonis. Included in SWTC's 2009-2010 CWP.

Adonis – Rattlesnake 115kV Line: A part of constructing a new 115 kV line from Saguaro to Rattlesnake (joint project with CAP) that includes the addition of a new substation, Adonis. Included in SWTC's 2009-2010 CWP.

CAP system loop into Sandario 115kV Lines: Loop the CAP Sandario to Brawley 115kV line to SWTC Sandario Substation (joint project with CAP). Included in SWTC's 2009-2010CWP.

CAP system loop into San Joaquin 115kV Lines: Loop the CAP Brawley to San Xavier

115kV line to a new SWTC San Joaquin Substation (joint project with CAP). Included in SWTC's 2009-2010 CWP.

Valencia – Black Mountain 115kV Line: Construct a new 115 kV line from the CAP line termination east of Black Mountain substation to the existing SWTC Valencia (joint projects with CAP). Included in SWTC's 2009-2010 CWP.

Marana – Avra Valley 115 kV Line: Upgrade the existing line to 1272 ACSR conductor. Included in the SWTC's 2009-2010 CWP.

Apache – Hayden loop into San Manuel 115kV Line: Loop the SWTC Apache to Hayden 115kV line to APS San Manuel Substation. Included in SWTC's 2009-2010 CWP.

Avra Valley – Sandario Tap 115kV Line: Upgrade the existing line to 1272 ACSR conductor. To be included in SWTC's 2011-2013 CWP.

Sandario Tap – Three Points 115kV Line: Upgrade the existing line to 1272 ACSR conductor. To be included in SWTC's 2011-2013 CWP.

Marana Tap – Marana 115 kV Line: Upgrade the existing line to 1272 ACSR conductor. To be included in SWTC's 2011-2013 CWP.

Pinal Central – ED2 Substation 115 kV Line: Construct a new 15 kV line from Pinal Central to the existing ED2 Substation. To be included in SWTC's 2011-2013 CWP.

Saguaro to Adonis 115 kV Line Loop-in to Naviska: Loop the Saguaro to Adonis 115 kV Line into a new SWTC Naviska Substation. To be Included in a future SWTC CWP.

CAP system loop into Picture Rocks 115kV Lines: Loop the CAP Twin Peaks to Sandario 115kV line to a new SWTC Picture Rocks Substation (joint project with CAP). To be Included in a future SWTC CWP.

Catalog of 500kV Projects - Twenty Year Planning Horizon	
Winchester/Willow – SunZia Interconnection	Willow – Winchester
Tortolita – Winchester	Pinal Central – Winchester
Winchester – Vail Single Circuit	Winchester – Vail Double Circuit
Vail – South Loop	South Loop – Three Points
Pinal West – Three Points	Tortolita – North Loop Double Circuit

Table 30. Catalog of 500kV Projects – Twenty Year Planning Horizon

Catalog of 345kV Projects - Twenty Year Planning Horizon	
Tortolita – North Loop Double Circuit	Tortolita – Marana Tap
Tortolita – North Loop Single Circuit	Marana Tap – North Loop
North Loop – Rillito	Marana Tap – DMP
Rillito - Northeast	DMP – SS 30
Northeast – East Loop	SS 30 – South Loop
East Loop – Vail	SS 30 – Vail
East Loop - Irvington	Three Points – SS 30
South Loop – Pinal West 2	Marana Tap – Three Points
Winchester – Vail Single Circuit	Three Points – Bicknell
Winchester – Vail Double Circuit	Vail – South Loop – Bicknell (loop-in)
Willow - Winchester	Apache – Vail Single Circuit
Vail – Irvington	Apache – Vail Double Circuit
South Loop - Irvington	Pinal West – South Loop PST
Vail – South Loop 2	

Table 31. Catalog of 345kV Projects – Twenty Year Planning Horizon

Catalog of 230kV Projects - Twenty Year Planning Horizon	
Apache - Butterfield	Winchester - Apache
Adams Tap to Pantano	Butterfield - Bicknell
Pantano – Nogales Tap	Nogales Tap – Del Bac
Del Bac - DMP	DMP - Marana Tap
Vail – San Rafael	Pantano – Kartchner
Bicknell – San Rafael	San Rafael – CS2
San Rafael - Mural	Adams Tap – Mural
Bicknell – Sahuarita PST	Kartchner – CS2
Apache – Adams Tap	Pantano – South Loop – Sahuarita (loop-in)

Table 32. Catalog of 230kV Projects – Twenty Year Planning Horizon

Catalog of 138kV Projects – Twenty Year Planning Horizon	
Tortolita – Marana (TEP – New Corridor)	Marana – SS No 1
Marana Double Circuit Tap	SS No 1 – North Loop
North Loop – Naranja	Orange Grove – SS NO6
Naranja – Rancho Vistoso	SS NO6 – SS NO7
Rancho Vistoso - Catalina	SS NO7 – Northeast
Irvington – Kino	Twenty Second – SS NO15
Kino – Downtown	Twenty Second – SS NO14
Downtown - Tucson	SS NO14 – East Loop
Midvale – Spenser	SS NO14 – Northeast
Vail –SS NO33	Vail – SS NO17
SS NO33 – Swan Southlands	SS NO15 - Irvington
Swan Southlands – SS NO22	Canoa Ranch – Duval Clear
Hartt – SS NO29	Canoa Ranch – SS NO25

Table 33. Catalog of 138kV Projects – Twenty Year Planning Horizon

Catalog of 115kV Projects – Twenty Year Planning Horizon	
115kV Projects	**Comments**
Avra – Sandario Tap	Sandario Tap – Three Points
Three Points - Bicknell	Saguaro - Naviska
Naviska - Marana	

Table 34. Catalog of 115kV Projects – Twenty Year Planning Horizon

27. Conclusions

The primary objective of SATS is to have a 20 year transmission plan covering the SATS footprint. Agreement to conduct the study as a "single system" is a key principle for the study. A work plan to achieve this objective, which includes the study scope and schedule, plus guidance on the study process, methodology, planning assumptions and criteria was jointly developed by the entire group of participants. The following are key conclusions and observations of the SATS study effort:

There are significant benefits of a coordinated subregional study effort using a single system approach. The SATS participants directly involved in developing the study scope; in developing alternative strategies; in modeling and analysis; and documenting results gained a much better understanding of current and emerging system issues than would have been otherwise possible by working independently. Participants who diligently participated in the many meetings and teleconferences, and who reviewed the documentation provided excellent feedback, valuable information and insights that could not have been accessed otherwise.

Specific benefits of joint planning include the following:

- Provides a framework for SATS Transmission Providers to prepare capital budgets and ten year plans
- SATS provides a forum to ensure accuracy of planning models, and to identify system issues involving interconnected transmission facilities, and to jointly develop mutually beneficial solutions;
- Provides a protocol for establishing "need" during project siting activities before regulators;
- Potentially higher reliability, through the use of multiple corridors versus multi-

circuits in single corridors wherever possible;

- Identification of potential joint projects which could result in lower overall construction requirements;
- Working with adjacent subregional study groups provides an effective means to resolve seams issues;
- Lower individual technical and financial risk through better information and creative group thinking;
- Lower cost, aesthetic and environmental impacts through pursuit of possible joint projects.

Conducting a subregional study looking out beyond the ten year planning horizon creates a sound basis for developing short-term plans in the context of a long-term view. Key findings include:

- Identified key EHV strategies to serve saturated load at ultimate buildout;
- Identified potential future transmission corridors and substation sites;
- The plan recommends flexibility in view of uncertainty considering alternatives to minimize long term risk;
- Worked collaboratively with the Cochise County stakeholders in the pursuit of developing a short-term (3 to 5 year) plan to address existing contingency issues which will provide a long-term solution;

Establishing a subregional study group facilitates an on-going process to solve remaining or emerging issues:

- Five year planning horizon dilemma, described in Section 15, is to be addressed in the SATS 2009 study plan. The problem has been relatively well defined and divided into discrete geographical study areas within SATS;
- Ongoing effort will continue to guide and inform the public in stakeholder forums as well as Transmission Providers' capital budgets and ten year plans

28. Recommendations and 2009 SATS Study Plan

Recommendations for the SATS study are documented as a list of actions in the proposed 2009 SATS Study Plan as follows:

Proposed 2009 SATS Study Plan

- Present plan & subsequent findings to SWAT, WestConnect and to local stakeholders
- Revise load forecasts
- Engage SATS in early case building to ensure accuracy of database for 2009 ten year planning cases:
  - Focus on Arizona for ten year planning to include cases for years 1 through 5 plus year ten;
  - Preparation for ACC ten year plans, RMR, BTA and compliance studies;
  - Provide support and documentation to other regulatory agencies such as FERC and Rural Utility Services (RUS);
- Investigate implications of increased FMI loads in SATS study footprint:
  - Seek input from, and participation by FMI to address their anticipated plant expansion;
- Investigate alternative configurations to mitigate high flows on the Winchester 345/230kV transformer, Apache – Bicknell 230kV line and 230/345kV Bicknell transformer caused by EHV system contingencies;
- Develop and evaluate alternatives to the two joint Tortolita – North Loop 345kV proposal based on the SPPR Three Terminal proposal;
- Investigate impact of SunZia in coordination with CATS EHV, NM, SWAT RTTF and other entities;
- Develop and evaluate alternatives for joint SWTC/TEP substation(s) to supply TEP/Trico loads south of Tucson;
- Continue Cochise County planning in an effort to comply with ACC recommendations;
- May conduct studies to accommodate renewable projects;
- Complete capital cost estimates and economic analysis, including losses;
- Identify potential projects;
- Conduct Scenario Sensitivity analysis, such as Load Forecast, Efficiency, Local Renewable Resources, Local & Distributed Generation, and location of external resources.

29. Appendices

29.1. Appendix A: Study Scope and Schedule

29.2. Appendix B: Table I. NERC Transmission System Standards:

Table I. Transmission System Standards – Normal and Emergency Conditions

Category	Contingencies	System Limits or Impacts		
	Initiating Event(s) and Contingency Element(s)	System Stable and both Thermal and Voltage Limits within Applicable Rating[a]	Loss of Demand or Curtailed Firm Transfers	Cascading Outages
A No Contingencies	All Facilities in Service	Yes	No	No
B Event resulting in the loss of a single element.	Single Line Ground (SLG) or 3-Phase (3Ø) Fault, with Normal Clearing: 1. Generator 2. Transmission Circuit 3. Transformer Loss of an Element without a Fault	Yes Yes Yes Yes	No [b] No [b] No [b] No [b]	No No No No
	Single Pole Block, Normal Clearing[e]: 4. Single Pole (dc) Line	Yes	No[b]	No
C Event(s) resulting in the loss of two or more (multiple) elements.	SLG Fault, with Normal Clearing[e]: 1. Bus Section 2. Breaker (failure or internal Fault)	Yes Yes	Planned/ Controlled[c] Planned/ Controlled[c]	No No
	SLG or 3Ø Fault, with Normal Clearing[e], Manual System Adjustments, followed by another SLG or 3Ø Fault, with Normal Clearing[e]: 3. Category B (B1, B2, B3, or B4) contingency, manual system adjustments, followed by another Category B (B1, B2, B3, or B4) contingency	Yes	Planned/ Controlled[c]	No
	Bipolar Block, with Normal Clearing[e]: 4. Bipolar (dc) Line Fault (non 3Ø), with Normal Clearing[e]: 5. Any two circuits of a multiple circuit towerline[f]	Yes Yes	Planned/ Controlled[c] Planned/ Controlled[c]	No No
	SLG Fault, with Delayed Clearing[e] (stuck breaker or protection system failure): 6. Generator 7. Transformer 8. Transmission Circuit 9. Bus Section	Yes Yes Yes Yes	Planned/ Controlled[c] Planned/ Controlled[c] Planned/ Controlled[c] Planned/ Controlled[c]	No No No No

D [d] Extreme event resulting in two or more (multiple) elements removed or Cascading out of service.	3Ø Fault, with Delayed Clearing [e] (stuck breaker or protection system failure): 1. Generator 2. Transmission Circuit 3. Transformer 4. Bus Section 3Ø Fault, with Normal Clearing [e]: 5. Breaker (failure or internal Fault) 6. Loss of towerline with three or more circuits 7. All transmission lines on a common right-of way 8. Loss of a substation (one voltage level plus transformers) 9. Loss of a switching station (one voltage level plus transformers) 10. Loss of all generating units at a station 11. Loss of a large Load or major Load center 12. Failure of a fully redundant Special Protection System (or remedial action scheme) to operate when required 13. Operation, partial operation, or misoperation of a fully redundant Special Protection System (or Remedial Action Scheme) in response to an event or abnormal system condition for which it was not intended to operate 14. Impact of severe power swings or oscillations from Disturbances in another Regional Reliability Organization.	Evaluate for risks and consequences. ▪ May involve substantial loss of customer Demand and generation in a widespread area or areas. ▪ Portions or all of the interconnected systems may or may not achieve a new, stable operating point. ▪ Evaluation of these events may require joint studies with neighboring systems.

a) Applicable rating refers to the applicable Normal and Emergency facility thermal Rating or system voltage limit as determined and consistently applied by the system or facility owner. Applicable Ratings may include Emergency Ratings applicable for short durations as required to permit operating steps necessary to maintain system control. All Ratings must be established consistent with applicable NERC Reliability Standards addressing Facility Ratings.

b) Planned 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 reliability of the interconnected transmission systems. To prepare for the next contingency, system adjustments are permitted, including curtailments of contracted Firm (non-recallable reserved) electric power Transfers.

c) Depending on system design and expected system impacts, the controlled interruption of electric supply to customers (load shedding), the planned removal from service of certain generators, and/or the curtailment of contracted Firm (non-recallable reserved) electric power Transfers may be necessary to maintain the overall reliability of the interconnected transmission systems.

d) A number of extreme contingencies that are listed under Category D and judged to be critical by the transmission planning entity(ies) will be selected for evaluation. It is not expected that all possible facility outages under each listed contingency of Category D will be evaluated.

e) Normal clearing is when the protection system operates as designed and the Fault is cleared in the time normally expected with proper functioning of the installed protection systems. Delayed clearing of a Fault is due to failure of any protection system component such as a relay, circuit breaker, or current transformer, and not because of an intentional design delay.

f) System assessments may exclude these events where multiple circuit towers are used over short distances (e.g., station entrance, river crossings) in accordance with Regional exemption criteria.

29.3. Appendix C: Study Models

29.4. Appendix D: Load Forecast

MW

Year	SWTC	TEP	CAP	APS	Total
2008	605	2,369	124	46	3144
2009	638	2,439	124	47	3248
2010	675	2,509	124	49	3357
2011	713	2,582	124	50	3468
2012	756	2,656	124	51	3587
2013	797	2,731	124	52	3705
2014	839	2,807	124	54	3824
2015	878	2,886	124	55	3943
2016	923	2,966	124	56	4069
2017	972	3,047	124	57	4200
2018	1024	3,130	124	59	4337
2019	1082	3,213	124	60	4479
2020	1144	3,299	124	62	4629
2021	1211	3,386	124	63	4784
2022	1284	3,474	124	65	4947
2023	1364	3,564	124	66	5118
2024	1452	3,655	124	68	5299
2025	1547	3,748	124	70	5489
2026	1636	3,842	124	72	5674
2027	1725	3,938	124	73	5860
2028	1814	4,035	124	75	6048

TEP 10 Y Increase	420	761	-	12	1193
TEP 20 Y Increase	1,209	1,666	-	29	2904

29.5. Appendix E: SATS-SPPR Taskforce Study Plan

SATS-SPPR Taskforce

Study Plan:

A study plan has been developed and approved to study the following four scenarios:

1. Study the SPPR option using the SATS study cases to determine if the SPPR option will work within the SATS Transmission Plan.

2. Study a hybrid option using the SATS 345kV option with appropriate 345/230/115 transformation to maintain the current voltage levels at the appropriate buses.

3. Study a hybrid option which allows for double circuit 230/345 on the same structures (known right-of-way issues.)

4. Study a short term 230kV option (SPPR Plan) with the capability of converting to 345kV (SATS Plan) at a future point in time.

Study Plan Schedule:

		Status	Date
I.	Study Plan development	Completed	9/08
II.	Base Case Development	In process	11/15/08
III.	Power flow Analysis	To be Completed	11/30/08
IV.	Final Report	To be Completed	12/30/08

29.6. Appendix F: Cochise County Study Group Meeting Notes

November 8, 2007 Meeting Notes

Main Points

The group agreed its objective would be:

To determine and recommend transmission solution[s] using 115, 138,

and 230 kV lines and substations to solve existing N-1 transmission problems within southern Cochise County. The recommendation[s] will be made November 26, 2007 and January 31, 2008.

Issues that the group agreed needs to be discussed at a later date:

- *Saturation study for Cochise County*
- *Short term solutions*
- *Funding*

Notes

Modeling guidelines:

1) Will use SATS' 20 year case
2) Will not model TEP's 44 kV or APS generators

Possible transmission solutions:

1) 230 kV from San Rafael to Mural and then at a much later date, 230 kV from Mural north toward the I-10 corridor.
2) 230 kV from the I-10 corridor south to a new 230/69 kV substation north of Sierra Vista.
3) Tie TEP's 138 kV to SWTC's 115 kV
4) Tie radial transmissions together using transmission lines and substations
    a. San Rafael to Kartchner using a 230 kV line and 230/115 kV substation

Possible short term solutions:

1) APS to SSVEC 69 kV
2) Capacitors at San Rafael
3) Upgrade SSVEC's 69 kV lines
4) SSVEC to TEP 69 kV

Action Items

1) SSVEC to describe proposed TEP 138 to SWTC 115 kV tie so that TEP's bond counsel can provide comments and viability per TEP's "2 county" bond requirements.

2) SSVEC to investigate possible 138 kV corridors across Ft. Huachuca Military.
3) SWTC to do load flow analysis for possible solutions and present them at November 20 SATS meeting.
4) Agenda for next South of SATS meeting to be determined at November 20 SATS meeting.
5) Next South of SATS meeting will be at TEP on Monday, November 26, starting at 9 AM.

Technical Meeting South of SATS — Thurs 11/18

NAME	COMPANY	EMAIL
DAVID BRYAN	SSVEC	dbryan@ssvec.c
Ron Orozco	SSVEC	rorozco@ssvec.co
Bill Pullum	SSVEC	bpullum @ ssvec.com
Gary Trent	TEP	strent@ tep. com
ABHISHEK SINGH	APS	Abhishek.Singh@aps.com.
Andy Meyer	TEP	ameyer@ tep.com
Cary Patten	APS	Cary.Patten@APS.com
STAN SIERRA	APS	STANLEY.SIERRA@ AP.Com
Ron Belval	TEP	rbelval@tep.com
Ray Som	SWTC	rsom@swtransco.coop
Leonard York	WAPA	YORK@ WAPA.GOV
EvaMarie King	SWTC	eking@swtransco .coop.
BRUCE EVANS	SWTC	bevans@swtransco.coop

6)

November 26, 2007 Meeting Notes

To determine and recommend transmission solution[s] using 115, 138, and 230 kV lines and substations to solve existing N-1 transmission problems within southern Cochise County. The recommendation[s] will be made November 26, 2007 and January 31, 2008.

1. Introductions – see sign in sheet in Appendix A
2. Agenda Modifications – none
3. Review and approval of objective and notes – none
4. Review of possible transmission solutions – EvaMarie King
    a. EvaMarie presented her study as shown in Appendix B.
    b. There was discussion and questions on each of the options.
    c. David Bryan discussed the results of a few analyses he had done.
    d. Detailed cost estimates were received after the meeting and included in Appendix C.
5. Possible Transmission Solutions to Carry Forward
    a. SWTC 230 kV Kartchner Loop
        i. Description of Proposed Solution
            1. Build 230 kV line from SWTC's San Rafael to SWTC's Kartchner
            2. Add 230/69 kV substation at Kartchner
            3. Rebuild Pantano to Kartchner from 115 kV to 230 kV
            4. Convert Pantano from 230/115 kV substation to 230 kV breaker station.
            5. Retire Kartchner 115 kV and Pantano 115 kV
        ii. APS Comments
            1. By 2023, APS will take radial 230 kV line from San Rafael to Mural. APS will install 230/69 kV substation at that time.
            2. APS will not participate in 230 kV loop until radial 230 kV line is built.

iii. TEP and Ft. Huachuca were not present to provide comments.
iv. WAPA will not participate.
v. "Ballpark" cost is $40 million.
vi. Minimum of 7 years to engineer and construct.

b. SWTC 230 kV Cooperative #2 230 kV Loop
   i. Description of Proposed Solution
      1. Build 230 kV line from SWTC's San Rafael to new Cooperative #2 substation, a 230/69 kV substation, located north-central Sierra Vista.
      2. Build 230 kV line from Cooperative #2 to Sloan or Pantano.
   ii. APS Comments
      1. By 2023, APS will take radial 230 kV from San Rafael to Mural. APS will install 230/69 kV substation at that time.
      2. APS will not participate in 230 kV loop until radial 230 kV line is built.
   iii. TEP and Ft. Huachuca not present to provide comments.
   iv. WAPA will not participate.
   v. "Ballpark" cost is $34 million.
   vi. Minimum of 7 years to engineer and construct.

c. Short Term Solutions
   i. Solutions currently being done
      1. APS to SSVEC 69 kV tie in Sierra Vista
      2. SSVEC 69 kV line upgrades
      3. SWTC 69 kV capacitors in Sierra Vista and Benson
   ii. Other Solutions to consider
      1. TEP 138 to SWTC 115 tie line and substation
      2. Generation in Sierra Vista
      3. SSVEC 69 kV line upgrades

6. Rewriting Objective

a. It was pointed out that our proposed solutions don't match the SSATS' objective statement.
b. It was agreed that the objective statement would go from:

To determine and recommend transmission solution[s] using 115, 138, and 230 kV lines and substations to solve existing N-1 transmission problems within southern Cochise County. The recommendation[s] will be made November 26, 2007 and January 31, 2008.

To determine and recommend short and long term transmission solution[s] to solve existing N-1 transmission problems within Cochise County. The recommendation[s] will be made November 26, 2007 and January 31, 2008.

7. Report Outline
    a. Items/discussion to be put in the report of this group was discussed.
    b. The report will have the following sections.
        i. Summary
        ii. Description of companies & transmission system in Cochise County, which will come from SATS report and SSATS group.
        iii. Summary of issues in Cochise County, which will come from 2007 ACC BTA, notes from SATS, and SSATS group.
        iv. Description of options studied, which will come from SWTC.
        v. Summary of loadflows & results, which will come from SWTC.
        vi. Recommendation, which will come from SSATS group
        vii. Appendix A, meeting notes
        viii. Appendix B, loadflows, which will be available in PDF format on a CD but not printed
8. Action Items
    a. SSVEC to do action items from last meeting, which are listed below

i. SSVEC to describe proposed TEP 138 to SWTC 115 kV tie so that TEP's bond counsel can provide comments and viability per TEP's "2 county" bond requirements.

ii. SSVEC to investigate possible 138 kV corridors across Ft. Huachuca Military.

b. Detail cost estimates of two proposed solutions

9. Next meeting

a. **Wednesday, January 9, 2008** at location and time TBD

b. Agenda

i. Review details of two long term solutions.

ii. Review short term solutions.

South of SATS
November 26, 2007

David Bryan	SSVEC	dbryan@SSVEC.com
Paul Roopley	SSVEC	PRoopley@SSVEC.com
RON OROZCO	"	ROROZCO@SSVEC.COM
ANSELMO TORRES	"	ATORRES@SSVEC.COM
Ray Som	swtc	rsom@swtransco.coop
STAN SIERRA	APS	STANLEY.SIERRA@APS.com
Cary Patten	APS	Cary.Patten@APS.com
Jim Rein	SWTC	jreine@swtransco.coop
BRUCE EVANS	SWTC	bevans@swtransco.coop
KEN BAGLEY	SSVEC/GENESEE	kabagley@cox.net
BILL PULLUM	SSVEC	bpullum@ssvec.com

January 9, 2008 Meeting

No notes were prepared for this meeting. Below is the meeting summary provided to SATS by David Bryan on January 14, 2008.

5) Cochise County Study Update

David Bryan was asked to provide an update of the Cochise County Studies.

The notes of the Cochise County meeting held on January 9th have not been transcribed and were not available for this meeting. The focus of the meeting was to discuss the two known high voltage (HV) options that were determined to be viable for study (230 kV loop from Pantano to Kartchner to San Rafael and a 230 kV loop from Sloan to San Rafael) along with a new option that was provided for study only recently by SSVEC's consultant. This new option involves the construction of a new 230 kV line from San Rafael to a new 230/115/69 kV substation located next to Kartchner Substation. A 115 kV tie from this new substation to Kartchner would be made, along with a 69 kV tie to the SSVEC 69 kV system. SSVEC would in turn, rebuild certain existing 69 kV lines back to Apache Generation, to 795 ACSR conductor. However, further review for this 3rd option showed a transformer with the capacity ratings envisioned was extremely unusual, and would make the transformer expensive and difficult to integrate into the system. Therefore, this option was dropped. The studies also revealed limitations with this option, in the 2019/2020 time frame for the loss of Butterfield to San Rafael.

Participants at the Cochise County meeting agreed that some kind of 230 kV loop is the solution in this area. The proposed solution presented to the group by SWTC consisted of a new 230 kV line from Sloan Substation to Huachuca Substation, operated radially initially, but looped from Huachuca to San Rafael after 2020. However allocation of the $40M cost of 230 kV reinforcement requires further discussion. According to SWTC's Board Policy 7.12, SSVEC would pay for the first part of the 230 kV loop as a Direct Assignment Facility. When a loop that integrates these proposed facilities into the area bulk network is completed, it would then become a System Facility. SSVEC argued that building over 37+ miles of radial 230 kV transmission to a new substation, without

completing the loop does not make sense. There will be minimum distance separating any new transmission substation and San Rafael and efforts should be made to construct the 230 kV loop, as one project, instead of an initial radial transmission line and substation, that SSVEC would be required to bear the costs of before it is integrated into the transmission system. SSVEC would like to see some kind of formal cost-sharing agreement in the project.

David noted that APS and Fort Huachuca were also in attendance at the meeting, but Western was not. At this time, no other entities have expressed an interest in participating in the cost of a 230 kV loop in the area.