Department of Energy

Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

PUBLIC AFFAIRS

January 28, 2010

In reply refer to: DK-7

Richard van Dijk, VP, Steering Committee
Better Way for BPA
PO Box 863
Yacolt, WA 98675

RE: FOIA #BPA-2010-00629-F

Dear Mr. van Dijk:

This response is a partial release to your Freedom of Information Act (FOIA) request for information that you made to the Bonneville Power Administration (BPA).

You requested:
A copy of the Draft Planning Report for the I-5 Corridor Reinforcement Project dated September 7, 2007 and the appendices.

Response:
BPA has provided a copy of the responsive document in its entirety minus the appendices. BPA will continue to review the appendices for release determination. Your fees have been waived.

I appreciate the opportunity to assist you with this matter and appreciate your patience. If you have any questions about this letter, please contact Laura M. Atterbury, Freedom of Information Act/Privacy Act Specialist, at 503-230-7305.

Sincerely,

/s/ Christina J. Brannon

Christina J. Brannon
Freedom of Information Act/Privacy Act Officer

Enclosure: Responsive Document

-Draft Report-

I-5 Corridor Reinforcement Project

September 7th 2007

By Anthony Radcliff

BPA Transmission Services

Transmission Planning

I. Introduction

The main grid facilities located in the I-5 corridor from north to south are Paul, Napavine, Allston, Keeler, and Pearl substations. The Southwest Washington and Northwest Oregon load service area includes the cities of Portland Oregon and Vancouver Washington, which include high concentrations of industrial, commercial, and residential load. The Southwest Washington and Northwest Oregon load area is served by the following main grid sources: Paul-Napavine-Allston #1, Paul-Allston #2, Allston-Keeler, and Ostrander-Pearl 500kV lines. Within the service area, three significant paths are monitored to ensure all lines stay within their thermal capabilities and maintain voltage stability. The significant paths are: South of Napavine, South of Allston, and Keeler-Pearl.

The highest loading for these paths, occurs during peak summer load conditions combined with high north to south transfers from Canada through the Northwest to California. The high north to south flows occur due to market conditions in California, excess generation in Canada and the Northwest, and high energy demands in California.

II. Purpose of Study

Under high north to south flow conditions on the I-5 Corridor transmission system, critical 500kV line outages can cause overloads and voltage instability on the underlying 230 and 115 kV systems. The worst single outages for the I-5 corridor are the loss of Allston-Keeler or Keeler-Pearl 500kV lines. The worst common mode outages are the double 500kV line loss between Paul and Allston and a breaker failure at Pearl 500kV substation which takes out the Pearl-Ostrander and Keeler-Pearl 500kV lines. The current practice to mitigate these problems is to use a remedial action scheme (RAS) to trip generation in the Northwest and Canada to reduce flows through the I-5 corridor transmission system. In the event of any of these outages as much as 2700MW of generation

can be dropped. The South of Napavine, South of Allston, and Keeler-Pearl paths are operated within established limits, which are reviewed annually.

Currently there are several generating projects under development along the I-5 corridor transmission system. Their combined capacity is roughly 1500MW. In order to reliably interconnect these generating projects and provide transmission service, new transmission facilities need to be constructed. BPA currently meets its obligations in the I-5 corridor with the existing RAS. However, load growth, new generation interconnections, and proposed changes to reliability criteria will cause the present RAS to be inadequate in the future.

The purpose of the proposed plan of service is as follows:

- Maintain transmission system reliability to BPA and WECC/NERC standards
- Accommodate transmission service requests
- Accommodate generation interconnection requests
- Meet increasing summer peak loads and the existing contractual obligations to serve them
- Reduce dependence on RAS

III. Study Methodology

The following study methodology was applied:

- Power flow,

  Power World software and BPA's budget base cases were used for this study.

- Voltage Stability,
  - Contingency analysis tool used to determine voltage stability.
  - Unsolved solutions were considered potentially unstable.
  - Margins of 5% and 2 ½% will be used for N-1 and N-2 outages respectively to establish the total transfer capability limits

- Transient Stability

  Transient stability studies will be performed for critical outages at the transfer limits

- Critical outage List

  N-1

  - Allston-Keeler 500kV line
  - Keeler-Pearl 500kV line

  N-2

  - Double line loss of Paul-Allston and Paul-Napavine 500kV lines
  - Double line loss of Paul-Allston and Napavine-Allston 500kV lines
  - Line fault and 500kV breaker failure contingency (4283) at the Pearl 500kV yard
  - Line fault and 500kV breaker failure contingency (4394) at the Keeler 500kV yard
  - Line fault and 500kV breaker failure contingency (4502) at the Allston 500kV yard
  - Double line loss of Allston-Trojan #1 and #2 230kV lines
  - Double line loss of St.Marys-Trojan and Rivergate-Trojan 230kV lines

  See Appendix A for the complete list of outages studied

- Generation Patterns Studied

  South of Napavine, South of Allston, and Keeler-Pearl path capacity varies with local load and generation patterns. BPA's Operations typically operates the I-5 corridor within established limits determined from studies where multiple generation patterns are considered. A range of limits are provided based on the most pessimistic and most optimistic generation patterns studied. The study methodology exposes different problems occurring under different system conditions. A detailed generation pattern analysis is covered in Appendix B.

A summary table of numbered generation patterns and what is modeled for each one, is provided for reference:

Table #1
I-Corridor Generators and Status

Pattern	Chehalis	Beaver	River Road	Swift	Merwin/Yale
G0	1	1	1	1	1
G1	0	1	1	1	1
G2	1	0	1	1	1
G3	0	0	1	1	1
G4	1	1	0	1	1
G5	0	1	0	1	1
G6	1	0	0	1	1
G7	0	0	0	1	1
G8	1	1	1	1	1
G9	0	1	1	1	1
G10	1	0	1	1	1
G11	0	0	1	1	1
G12	1	1	0	1	1
G13	0	1	0	1	1
G14	1	0	0	1	1
G15	0	0	0	1	1
G16	1	1	1	1	0
G17	0	1	1	1	0
G18	1	0	1	1	0
G19	0	0	1	1	0
G20	1	1	0	1	0
G21	0	1	0	1	0
G22	1	0	0	1	0
G23	0	0	0	1	0
G24	1	1	1	1	0
G25	0	1	1	1	0
G26	1	0	1	1	0
G27	0	0	1	1	0
G28	1	1	0	1	0
G29	0	1	0	1	0
G30	1	0	0	1	0
G31	0	0	0	1	0

On = 1
Off = 0

BPA Internally Monitored Paths along the I-5 Corridor

- Raver-Paul
    - Raver-Paul 500kV line
- South of Napavine

- Throughout this report the South of Napavine path will refer to just the 500kV lines in the path.
- Paul-Allston #2 500kV line
- Napavine-Allston (Paul-Allston #1) 500kV line

- South of Allston
  - Allston-Keeler 500kV line
  - Trojan-St. Mary's 230kV line
  - Trojan-Rivergate 230kV line
  - Lexington-Ross 230kV line
  - Merwin-St. John's 115kV line
  - Allston-St. Helens 115kV line
  - Astroria-Seaside 115kV line
- Keeler-Pearl
  - Keeler-Pearl 500kV line

- Reliability Criteria / Planning Standards
  - Thermal Limit Criteria:
    - Lines may not exceed their applicable thermal limit under any conditions.
    - Transformers may not exceed their thermal rating with all facilities in service conditions and may not exceed their emergency rating under outage conditions.
  - Voltage Limit Criteria:
    - All load bus voltages must maintain 100% or better voltage for all lines in service and a minimum of 95% voltage for outage conditions.
    - Some service areas allow for lower voltages than BPA's system. Those limits were applied for the specific load service area.
  - Voltage Stability Criteria:

    The real power margin criteria states:

- 5% real power margin for all lines in service and single contingencies
- 2.5% real power margin for all N-2 contingencies
- The real power margin criteria were applied using the QV Analysis tool in Power World. QV curves were constructed at various transfer levels near a thermal limit scenario. The voltage stability limit was determined from the transfer or path flow level with zero reactive power margin.

IV. Study Assumptions

- Base cases to be used
  - BPA's peak summer load budget base cases
  - The years 2008 (near term) and 2012 (long term) were studied
- Generation levels modeled in the studies:
  - Chehalis 520MW
  - (PGE) Beaver 492MW
  - (Clark) River Road 235MW
  - (PACW) Swift 210MW
  - (PACW) Yale and Merwin 130MW
  - (PGE) Port Westward 388MW
  - Mint Farm 248MW
  - Grays Harbor (Satsop) 628MW *
  - (Pacific Mountain Energy) Kalama 600MW *

  * These proposed new generating plants were included to stress the study cases. Actual generation developments could be different from these assumptions.
- Range of stress levels studied for critical cut planes affecting the area:
  - Canada-Northwest 2000 to 2850 MW
  - California-Oregon Intertie 3300 to 4800 MW
  - North of John Day 7000 to 8400 MW

- Thermal limits of critical equipment (summer ratings at 30° C ambient temp)
    - Chehalis-Longview #1 and #3 230kV lines, 1840Amps to tap; 1070Amps individually
    - Holcomb-Naselle 115kV line, 430Amps
    - Longview-Lexington 230kV line, 1070Amps
    - Trojan-St. Mary's 230kV line, 1315Amps
    - Merwin-St. John's 115kV line, 673Amps
    - Keeler-St. Mary's 230kV line, 1757Amps
    - Pearl-Ostrander 500kV line
        - The Pearl-Ostrander 500kV line was studied with the former rating of 1050Amps capacity; sagged for 50° C MOT. Since the initiation of the study the line has been re-rated for 80° C MOT; 2140Amp capacity.
    - Ross-Woodland 230kV line
        - The Ross-Woodland 230kV line will be upgraded by 2008 to 1300Amp capacity for N-0 and N-1 scenarios and 1500Amp capacity for N-2 scenarios.
- Remedial Action Scheme (RAS)
    - Applicable RAS was modeled for critical main grid outages
    - The maximum generation dropping for RAS was limited to approximately 2700MW
    - RAS generation dropping priority was as follows:
        - Available I-5 Corridor generation: Chehalis, Big Hanaford, Fredrickson, and new generation as applicable
        - BC Hydro: Revelstoke and MCA
        - Upper Columbia: Grand Coulee and Chief Joseph
    - Within the I-5 corridor, RAS was applied to trip generation on a "last on, first off" basis.
    - BC Hydro generation arming

- Generation dropping at BC Hydro was limited to a maximum of 1850MW.
- In this study it was assumed that if the sum of the I-5 and BC Hydro generation armed exceeded the maximum RAS limit of 2700MW, then generation at BC Hydro would not be dropped. Generating units at Upper Columbia would be dropped instead.

o South of Chehalis Sectionalizing Scheme (SOCSS)

- Opens the Chehalis-Longview 230kV lines #1 and #3, and Holcomb-Naselle 115kV lines in the event of an overload during a Paul corridor 500kV double line loss. This scheme is armed, in addition to generator dropping, when pre-contingency flows are very high on the South of Napavine path.

V. Existing System Performance

In the following analysis of the existing system performance, the peak summer 2008 base case loads were used.

All Lines in Service Performance

High transfers through the I-5 Corridor, coupled with peak loads and certain generation patterns, cause low voltages on the I-5 Corridor main grid transmission system. Historical (SCADA) data shows the bus voltage at Allston reduces simultaneously with high flow on the Allston-Keeler 500kV line. In the base case, low voltages were mitigated by switching reactors off, switching capacitor groups in, and changing taps to optimize the voltage profile of the case. At the thermal limit of the South of Allston path (2565MW) based on the studies, the Reactive Power Margin at the Allston 500kV bus with all lines in service was 724MVARs. The generation pattern for the thermal-limiting case for the South of Allston path

models Chehalis, Beaver, Swift, Yale, and Merwin generators off-line and River Road on-line (pattern G27 from table #1).

If the proposed new generation comes on-line in the I-5 Corridor, additional system improvements would be needed. For example, PacifiCorp's Merwin-View tap 115kV line may exceed its thermal limit under high local load and transfers with new generation interconnected in the Longview area with all lines in service.

Contingency Performance

South of Napavine Path:

In the event of a double 500kV line loss of either Paul-Allston and Paul-Napavine or Paul-Allston and Napavine-Allston, at high transfer levels, the parallel 230kV and 115kV facilities will overload. The overloaded facilities are the Chehalis-Longview #1 and #3 230kV and Holcomb-Naselle 115kV lines. The 230kV and 115kV lines become heavily loaded because they are the remaining connection on the Westside transmission system following the outage on the main grid.

In order to mitigate overloads, a remedial action scheme (RAS) is implemented, which drops up to 2700MW of generation in the I-5 corridor, Upper Columbia, and British Columbia Hydro. Dropping generation reduces north to south flows through the affected area. The I-5 corridor generating units armed for the RAS are Chehalis, Big Hanaford, and Fredrickson. In this study, it was assumed that new generators which are integrated north of the path will also be added to this RAS, to mitigate their impacts.

During heavy transfers dropping generation is inadequate to off-load the underlying network and the Westside system needs to be sectionalized with the South of Chehalis System Sectionalizing Scheme (SOCSS), which opens the Chehalis-Longview #1 and #3 230kV and Holcomb-Naselle 115kV lines. This

scheme eliminates the thermal overloads but reduces the reactive margin of the system. This could lead to potential voltage instability as the Portland/Vancouver area loads grow.

The SOCSS is armed when the South of Napavine path loading is in the range of 1460MW – 2250MW. The South of Napavine 500kV path is presently limited to a range of 2090MW-3320MW during the peak summer load season to ensure voltage stability and thermal limits are maintained.

The South of Napavine thermal and voltage limits determined from this study are as follows:

- Thermal Limits
    - South of Napavine path limit = 1835MW to 2321MW
        - Limiting Outage: N-2 Paul-Allston/Paul-Napavine
        - Limiting Facility: Longview-Longview Tap 230kV line (1840Amps capacity)
        - Lower path limit = 1835MW
            - Generation Pattern: Chehalis, Beaver, Swift, Yale, and Merwin off-line and River Road on-line (Pattern G27)
        - Upper path limit = 2321MW
            - Generation Pattern: Chehalis, River Road, Swift, Yale, Merwin and Beaver on-line (Pattern G0)

- Voltage Stability Limits
    - The voltage stability limits were determined using the QV analysis tool at several path loading levels. Certain capacitor groups were switched on (based on their voltage set-points), transformer taps were locked, SVCs were allowed to adjust, and generators were modeled with low side voltage control.

- South of Napavine path limit = 2194MW to 3050MW
  - Limiting Outage: N-2 Paul-Allston/Paul-Napavine w/SOCSS
  - Limiting Facility: System wide voltage collapse
  - Lower path limit = 2194MW
    - Generation Pattern: Chehalis, Beaver, River Road, Swift, Yale, and Merwin off-line (Pattern G31)
  - Upper path limit = 3050MW
    - Generation Pattern: Chehalis, River Road, Yale, and Merwin on-line and Beaver and Swift off-line (Pattern G10)

In the South of Allston path limit study, the South of Napavine path was already beyond its voltage stability limit when the South of Allston path reached its thermal limit for over half of the operating conditions studied. This would indicate that under certain generation patterns the South of Napavine path would limit first based on voltage stability.

South of Allston Path:

The South of Allston and Keeler-Pearl paths are in series and all limits will refer to South of Allston path flows.

With the existing system, the most limiting contingency for the South of Allston path is a line fault and a 500kV breaker failure at Pearl substation, which causes an outage of the Keeler-Pearl and Ostrander-Pearl 500kV lines. The limiting element is the St. Mary's-Keeler 230kV line.

In order to mitigate overloads on the existing system a remedial action scheme is implemented, which drops up to 2700MW of generation in the I-5 corridor, Upper

Columbia, and British Columbia Hydro. Dropping generation reduces north to south flows through the affected area.

Currently, the South of Allston path is limited to a range of 2870MW-3090MW during the summer operating season to ensure thermal limits are maintained.

The South of Allston thermal limits determined from this study for the five most critical contingencies are as follows:

- Thermal Limits
    - South of Allston path limit = 2565MW to 3153MW
        - Limiting Outage: Pearl 500kV breaker failure contingency (Keeler-Pearl-Ostrander outage)
        - Limiting Facility: Keeler-St. Mary's 230kV line (study rating is 1757Amps)
        - Lower path limit = 2565MW
            - Generation Pattern: Chehalis, Beaver, Swift, Yale, and Merwin off-line and River Road on-line (Pattern G27)
        - Upper path limit = 3153MW
            - Generation Pattern: Chehalis, Beaver, Swift, Yale, and Merwin on-line and River Road off-line (G4)
        - Re-terminating the Keeler-Pearl 500kV line into a new bay at Pearl would eliminate this outage.

- Thermal Limits
    - South of Allston path limit = 2683MW
        - Limiting Outage: Keeler 500kV breaker failure contingency (Allston-Keeler-Pearl outage)
        - Limiting Facility: Ross-Woodland 230kV line (study rating is 1070Amps)

        - Lower path limit = 2683MW
            - Generation Pattern: Beaver and Swift on-line and Chehalis, River Road, Yale, and Merwin off-line (Pattern G21)
        - The Ross-Woodland 230kV line will be upgraded to 1300Amps (1500Amps emergency) by 2008.

- Thermal Limits
    - South of Allston path limit = 2746MW
        - Limiting Outage: Allston 500kV breaker failure contingency (Napavine-Allston-Keeler outage)
        - Limiting Facility: Ross-Woodland 230kV line (study rating is 1070Amps)
        - Lower path limit = 2746MW
            - Generation Pattern: Beaver and Swift on-line and Chehalis, River Road, Yale, and Merwin off-line (Pattern G21)
        - The Ross-Woodland 230kV line will be upgraded to 1300Amps (1500Amps emergency) by 2008.

- Thermal Limits
    - South of Allston path limit = 2748MW
        - Limiting Outage: N-1 Keeler-Pearl 500kV line
        - Limiting Facility: Keeler-St. Mary's 230kV line (study rating is 1757Amps)
        - Lower path limit = 2748MW
            - Generation Pattern: Chehalis, Beaver, Swift, Yale, and Merwin off-line and River Road on-line (Pattern G27)

- Thermal Limits

- South of Allston path limit = 2837MW
  - Limiting Outage: N-1 Allston-Keeler 500kV line
  - Limiting Facility: St.Mary's-Trojan 230kV line (study rating is 1315 Amps, the may have been upgraded or may be upgraded in the near future)
  - Lower path limit = 2837MW
    - Generation Pattern: Chehalis, Beaver, Swift, Yale, and Merwin off-line and River Road on-line (Pattern G27)

The South of Napavine voltage stability limit was 2303MW (G27) and 2901MW (G2) with most local area generation off-line and on-line respectively. At the South of Allston path thermal limits, 2565MW (G27) and 2901 (G2), the South of Napavine path loadings were 2728MW (G27) and 2782MW (G2). For approximately half of the generation patterns studied the South of Napavine path loading was beyond its voltage stability limit when the South of Allston path was at it thermal limit. This indicates that system upgrades which only increase thermal capacity would not provide benefit without reactive power support for the main grid.

Other Overloaded Facilities Identified in the Study

The following facilities show up as overloaded in the studies under certain generation patterns. However, they appear to be caused by load growth (as apposed to transfers) based on the criteria that their Outage Transfer Distribution Factors (OTDF) is less than 1.5% with respect to north to south transfers.

(BPA & CCP) Longview-Cardwell-Lexington 115kV loop:
Sections of the Longview-Cardwell-Lexington 115kV loop exceed their thermal limits for a breaker failure contingency at Longview 115kV or Lexington 115kV. Each of these outages causes the loss of one end of the loop, which overloads the

other end. The overloads appear to be caused by local area load growth, but may be aggravated by new generation additions.

(BPA) Keeler-Forest Grove 115kV line:
Multiple outages cause overloads on the Keeler-Forest Grove 115kV line. The worst outage is the double circuit loss of Keeler-St. Mary's and St. Mary's-Trojan 230kV lines. The overload appears to be related to local area load service and is aggravated by local generation patterns. This line may require an upgrade to accommodate load growth and new generation additions.

(BPA) Allston-Rainier-Goble-St.Helens 115kV line:
Multiple outages overload the Allston-Rainier-Goble-St. Helen's 115kV line. The worst outage is the double line loss of Keeler-St. Mary's and St. Mary's-Trojan 230kV lines. The overloads appear to be related to local area load service and new generation additions.

(PAC) Astoria-Seaside-Cannon Beach 115kV line:
Multiple outages overload the Astoria-Seaside-Cannon Beach 115kV line. The worst outages are the double line loss of Keeler-St. Mary's and St. Mary's-Trojan 230kV lines and the line fault and 500kV breaker failure at Keeler, which causes the loss of the Allston-Keeler and Keeler-Pearl 500kV lines. The overloads appear to be related to a combination of local area load service and some parallel path flows (to the I-5 Corridor). The line may require an upgrade to accommodate load growth and new generation additions.

(PAC) Merwin-View Tap 115kV line:
In the event of high loading on the Merwin-View Tap 115kV line, PacifiCorp ramps down generation at Merwin and Yale generation to reduce loading on the line. Multiple outages cause overloads of the Merwin-View Tap 115kV line, with the worst being the double line loss of Keeler-St. Mary's and St. Mary's-Trojan 230kV lines. New generation additions at Longview will most likely increase the

loading. At future (higher) load levels and with new generation on-line, ramping generation at Merwin and Yale may no longer be adequate to prevent overloading the Merwin-View Tap 115kV line.

Summary of Existing System Performance

Based on the studies, the South of Napavine and South of Allston total transfer capability (TTC) range using the summer 2008 load forecast is 1835MW to 2321MW (without SOCSS) and 2565MW to 3153MW respectively. The voltage stability limit of the system, with SOCSS implemented, ranges from 2194MW to 3050MW for the South of Napavine path. Under certain conditions and generation patterns studied, the South of Napavine path voltage stability limit is more restrictive than the thermal limit for the South of Allston path.

Other thermal violations exist that are not directly transfer related, but are aggravated by load growth and new generation proposed in the I-5 corridor.

VI Alternatives and Analysis

A. Alternative 1 - Upgrading the 230 and 115 kV System

Initially Planning studied upgrading the lower voltage (230 and 115 kV) system to determine if it was feasible to incrementally fix the lower voltage system enough to accommodate the proposed new generation into the I-5 Corridor. This option includes rebuilding, re-conductoring, or re-sagging entire lines or sections of 230kV and 115kV lines in the I-5 Corridor (approximately 130 miles total), so they have the capacity to support the high transfers in the event of an outage on the main grid (500kV system). This alternative mitigates the thermal overloads. However, line upgrades do not mitigate the voltage instability problems identified.

Plan of Service

The plan of service for this alternative includes, at a minimum, the following line upgrades:

- (BPA) Longview-Chehalis 230kV line from Longview to tap (approximately 1.6miles), 1976Amp capacity
- (PGE) Keeler-St.Marys 230kV line, 1836Amp capacity
- (PGE) St.Marys-Trojan 230kV line, 1387Amp capacity
- (BPA) Ross-Woodland 230kV line, 1358Amp capacity
- (BPA) Longview-Lexington #2 230kV line, 1101Amp capacity
- (PAC) Merwin-View-Cherry 115kV line, 992Amp capacity
- (PAC) Astoria-Seaside-Cannon Beach 115kV line, 535Amp capacity
- (BPA) Allston-Rainier-Goble-St. Helens 115kV line, 945Amp capacity

These upgrades are the minimum required to alleviate overloads, do not eliminate the SOCSS, and assume any new generation is included in the existing RAS. Since the SOCSS is not eliminated by these lower voltage upgrades, the voltage stability limit of the South of Napavine path would limit the system prior to reaching the full capacity of the South of Allston path under certain conditions and generation patterns. Without eliminating the SOCSS, the increased available transfer capability (ATC) created by lower voltage upgrades is 0MW because 14 of the 32 patterns studied showed South of Napavine path voltage stability limits occurred before the existing South of Allston path thermal limits. The SOCSS would need to be eliminated to achieve South of Allston path capacity with lower voltage system upgrades.

To completely eliminate the SOCSS and utilize the full South of Allston path capacity for the worst case generation scenario (Pattern G27) the following additional capacity increases would be needed:

- (BPA) Longview-Chehalis 230kV line from Longview to tap, 2982Amp capacity
- (BPA) Longview-Chehalis #3 230kV line, 1550Amp capacity

- (BPA) Longview-Chehalis #1 230kV line, 1441Amp capacity
- (BPA) Olympia-Chehalis 230kV line, 1438Amp capacity
- (BPA) Holcomb-Naselle 115kV line, 560Amp capacity
- (BPA) Cathlamet-Cathlamet tap 115kV line, 319Amp capacity

The alternative of upgrading the lower voltage system is not recommended due to the voltage stability performance of the system following the double line loss of Paul-Allston and Paul Napavine 500kV lines and the large number of lines that would need upgrading to accommodate the proposed new generation in the queue. Also, this alternative does not permit any reduction to existing RAS generation dropping. This would require a significant increase in line upgrades, beyond what is described above.

B. Alternative #2 – Paul-Troutdale 500kV Line

Plan of Service

The NW Oregon/SW Washington plan of service (AKA Paul-Troutdale) was developed to provide additional capacity in the I-5 Corridor and was BPA's recommended plan of service in 2002. This plan of service was determined to be the most cost effective reinforcement to the I-5 Corridor. This alternative was studied to determine how it would perform under current system conditions.

The Paul-Troutdale 500kV line plan of service includes:

- Construct a new 500kV three breaker ring bus approximately 12 miles north of Allston substation (near Castle Rock WA) tied into the Napavine-Allston 500kV line.
    - This site was chosen to mitigate common corridor outages in the Paul-Allston transmission corridor.
- Construct a 500kV three breaker ring bus at the Troutdale 500kV yard

- Re-terminate Ostrander-Troutdale 500kV line and the Troutdale 500/230kV transformer into two of the new bay positions. The third bay position will be for the new 500kV line.
- Construct approximately 70 miles of new 500kV line from the new substation (north of Allston) to Troutdale

Although the new 500kV line would not extend all the way to Paul substation, the new 500kV station is yet unnamed, so the project will be referenced as "Paul-Troutdale" for the remainder of the report.

Study Results (Alternative #2)

New ATC

To determine the value of the Paul-Troutdale plan of service the new system's TTC must be determined and compared to the existing system's TTC. However, constructing a new 500kV line in the I-5 corridor reduces the impedance through the corridor and, thus, increases the power flow, which impacts the ATC.

The ATC increase was determined from comparing the pre-contingency path loading and path limit, using Power World's Contingency analysis, with the existing system and the system with Paul-Troutdale in service. The calculation compared like generation patterns to each other. The calculation is as follows:

ATC Increase = (Path Limit w/Paul-Troutdale – Path Limit Existing System) – (Pre-Contingency Loading w/Paul-Troutdale - Pre-Contingency Loading Existing System)

Contingency Performance

South of Napavine:

Certain components of the Paul-Troutdale plan of service mitigate common corridor outages in the Paul-Allston transmission corridor. The Tacoma-Chehalis and Chehalis-Longview 230kV lines run between the Paul-Allston 500kV lines up to approximately 12 miles north of Allston substation. The new substation associated with the Paul-Troutdale plan of service, would be tied into the Napavine-Allston section of the Paul-Allston #1 500kV line approximately 12 miles north of Allston substation. Therefore, the credible Paul Corridor double line loss is limited to the section of the corridor from the new substation to Allston, and the new 500kV line would be in parallel here to support the system.

In the event of a double 500kV line loss of Paul-Allston #2 and New Substation-Allston #1, at high transfer levels, the parallel 230kV and 115kV facilities are not overload with the new 500kV line in service. The new 500kV line provides a parallel path for power to flow through the I-5 Corridor and off-loads the parallel 230 and 115 kV systems in the event of a main grid outage. At significantly higher transfer levels, the Chehalis-Longview #1 and #3 230kV and Holcomb-Naselle 115kV lines could overload and additional upgrades would be required to increase transfers further.

The South of Napavine thermal limits determined from this study with the new 500kV line are as follows:

- Thermal Limits
    - South of Napavine path limit = 2522MW to 2986MW
        - Limiting Outage: N-2 Paul-Allston/New Substation-Allston 50kkV lines
        - Limiting Facility: Longview-Longview Tap 230kV line (study rating is 1840Amps)
        - Lower path limit = 2522MW
            - Generation Pattern: Chehalis, Beaver, River Road, Swift, Yale, and Merwin off-line (Pattern G31)
        - Upper path limit = 2986MW

- Generation Pattern: Chehalis, River Road, Swift, Yale, Merwin and Beaver on-line (Pattern G0)

Eliminate SOCSS

To fully utilize the South of Allston path ATC created by the new 500kV line, the South of Napavine path may be loaded beyond its thermal limits and the SOCSS may be required to mitigate thermal violations at the higher transfer levels. However, voltage instability in the Portland/Vancouver load service area may occur in the event the SOCSS is implemented at high transfer levels. In order to eliminate the SOCSS the following lines would require upgrades:

- Longview-Longview T 230kV (1.6 miles), 2519Amps.
- Longview-Chehalis #1 230kV (33.3 miles), 1218Amps
- Longview-Chehalis #3 230kV (31.2 miles), 1309Amps
- Holcomb-Naselle 115kV (21.1 miles), 466Amps
- The line ratings are the minimum values required

South of Allston:

The South of Allston and Keeler-Pearl paths are in series and all limits will refer to South of Allston path flows.

In the event of a line fault and 500kV breaker failure at Pearl substation, which causes an outage of the Keeler-Pearl and Ostrander-Pearl 500kV lines, the St.Mary's-Keeler 230kV line exceeds its thermal limit. In order to mitigate overloads a remedial action scheme is implemented, which drops up to 2700MW of generation in the I-5 corridor, Upper Columbia, and British Columbia Hydro. Dropping generation reduces north to south flows through the affected area.

The South of Allston thermal limits determined from this study with the new 500kV line plan of service are as follows:

- Thermal Limits
    - South of Allston path limit = 3553MW to 3804MW
        - Limiting Outage: Pearl 500kV breaker failure contingency (Keeler-Pearl-Ostrander outage)
        - Limiting Facility: Keeler-St. Mary's 230kV line (study rating is 1757Amps)
        - Lower path limit = 3553MW
            - Generation Pattern: Chehalis, Beaver, Swift, Yale, and Merwin off-line and River Road on-line (Pattern G27)
        - Upper path limit = 3804MW
            - Generation Pattern: Chehalis, Beaver, River Road, Swift, Yale, and Merwin on-line (Pattern G0)
        - The South of Allston TTC is increased by 988MW with the new 500kV line in service, based on comparisons with generation pattern G27, which is presently used to establish path limits. The ATC for the South of Allston path increases by approximately 763MW.

<u>Additional improvements to increase transfer capability</u>.

- Upgrade the (BPA) Longview-Chehalis 230kV line from Longview to the tap, approximately 1.6 miles, to 2140Amp capacity.

- Re-sag the (BPA) Napavine-Allston 500kV line section from approximately 5.55 miles south of Napavine substation, structure 7/1, to the new 500kV substation 12 miles north of Allston substation for 100° C operation.

- The line section reaches its thermal limit in the event of a line fault and 500kV breaker failure at Paul substation causing the loss of Olympia-Paul and Paul-Allston #2 500kV lines.
- The overloads occur under very high north to south transfer conditions with new generation additions north of the South of Napavine path.

- Re-sag the (PGE) St. Mary's-Trojan 230kV line for 1400 Amp capacity
  - The (PGE) St. Mary's-Trojan 230kV line reaches its thermal limit in the event of a line fault and 230kV breaker failure at Keeler.
  - The overloads occur under very high north to south transfer conditions with new generation additions north of the South of Allston path.

Reduced Generation Dropping for N-1 Outages

One objective for the Paul-Troutdale plan of service was to determine if the amount of RAS generation dropping for N-1 outages could be reduced. Two major outages in the I-5 Corridor would be impacted, the single line loss of either the Allston-Keeler or Keeler-Pearl 500kV lines. In this study, results were compared for two levels of generation dropping: 1700MW (reduced amount) and 2700MW (present limit).

The study results show reducing the amount of RAS generation dropping for N-1 outages only may not cause a reduction South of Allston path capacity when compared to the worst common mode contingencies with RAS. The calculated South of Allston path limit for N-1 contingencies with 1700MW of RAS generation dropping was compared to the South of Allston path limit for the line fault and 500kV breaker failure at Pearl with 2700MW of RAS generation dropping. All of the generation pattern scenarios showed the critical common mode contingencies still limited the system before the N-1 contingencies with reduced generation dropping.

The Paul-Troutdale 500kV line plan of service provides the following benefits:

- Creates a parallel 500kV path to the South of Napavine, South of Allston, and Keeler-Pearl paths, which prevents overloading the underlying system in the event of a main grid outage
- Increases the South of Napavine path capacity by:
    - 704MW TTC
    - 586MW ATC
    - The capacity increases were based on a comparison, assuming the same generation pattern presently used to establish limits for this path (G27).

- Re-conductoring the Longview to Longview tap line section to 2140Amp capacity increases the South of Napavine path capacity by an additional 299MW. Upgrading the following lines to the listed values eliminates the SOCSS for the generation patterns and flow levels studied:
    - Longview-Longview Tap 230kV = 2519Amps
    - Longview-Chehalis #3 230kV = 1309Amps
    - Longview-Chehalis #1 230kV = 1218Amps
    - Holcomb-Naselle 115kV = 466Amps

- Increases the South of Allston path capacity by:
    - 988MW TTC
    - 763MW ATC
    - The capacity increases were based on a comparison, assuming the same generation pattern presently used to establish limits for this path (G27).

- The path capacity gains are dependent on additional upgrades that are required for higher transfers, load growth, generation interconnection, and

to support a 500kV line terminated at Troutdale substation. The order of phase #1 upgrades is:

  - Construct new 500kV line
  - Upgrade (PAC) Merwin-View Tap-Cherry line
  - Upgrade (PAC) Troutdale-Gresham line, (PAC) Harrison-Lincoln line, and (PGE) Blue Lake transformer and Blue Lake reinforcements
  - The next limiter is the Keeler-St. Mary's 230kV line in the event of a line fault and 500kV breaker failure at Pearl

- Re-terminating the Keeler-Pearl 500kV line into a new bay at Pearl may increase the South of Allston path thermal capacity by eliminating the critical breaker failure outage. To increase capacity further, other upgrades are required, along with the re-termination. The order of upgrades for phase #2 is as follows:

  - Re-terminate the Keeler-Pearl line into a new bay at Pearl, increases the capacity by an additional 82MW
  - Upgrade the (BPA) Allston-Rainier-Goble 115kV line, increases capacity by an additional 286MW
  - The next limiter is the Trojan-St. Mary's 230kV line in the event of a line fault and breaker failure at the Keeler 230kV bus and the Napavine-New Substation 500kV line in the event of a line fault and 500kV breaker failure at Paul substation.
  - Approximate South of Allston path ATC increase = 368MW

- For phase #3 re-sag the St. Mary's-Trojan 230kV and Napavine-New Substation 500kV lines for 100° C operation increases the lines capacity to 1400 and 3500 Amps respectively.
  - Approximate South of Allston path ATC increase = 287MW

- These values assume only thermal limitations and that other paths are capable of handling the transfers

- The new 500kV line provides the possibility of reducing the amount of generation dropped for the Westside remedial action scheme
  - For single 500kV line outages the generation dropping could be reduced to 1700MW without reducing South of Allston path capacity for thermal violation.

Summary of Performance with the Paul-Troutdale Plan of Service

With the new Paul-Troutdale 500kV line, the TTC increase for the South of Napavine and South of Allston paths are 704MW and 988MW respectively. The ATC increase (TTC increase minus the path flow) for the South of Napavine and South of Allston paths are 586MW and 763MW respectively. In order to achieve the new TTC for the South of Allston path other lower voltage lines also need to be upgraded so they won't limit the system.

The I-5 corridor is operated near its capacity today and this project is needed to increase firm transfers beyond today's limits. Future load levels could result in more curtailments due to the loads' contribution to the overloads and voltage instability. A rough estimate for the cost of the 500kV portion of this project is in the range of $200M. Estimates are being updated.

C. Alternative #3 – Paul-Pearl 500kV Line

Another alternative that was studied was a new 500kV line from Pearl substation to a new substation north of Allston. For this study, it will be referred to as the Paul-Pearl alternative. A couple of routes for this line were considered. Each plan is as follows:

Plan of Service

The Paul-Pearl 500kV line plan of service includes:

- Construct a new three breaker ring bus 12 miles north of Allston substation (near Castle Rock WA) tied into the Napavine-Allston 500kV line.
    - This site was chosen to mitigate common corridor outages in the Paul-Allston transmission corridor.

- Multiple routes are possible for the Paul-Pearl 500kV line:
    - Construct approximately 100 miles of 500kV line from the new substation north of Allston toward the west side of the Portland/Vancouver load service area through Clatskanie, Timber, Carlton, and Sherwood substations to Pearl. This alternate route may require new right of way through forested areas.
    - Construct approximately 80 miles of new 500kV line from the new substation north of Allston paralleling the Ross-Lexington 230kV, Ross-St. John's 230kV, St. John's-Keeler 115kV, and Keeler-Oregon City 115kV lines to Pearl substation. This alternate route uses some of the existing right of way through Forest Park and Portland neighborhoods and may require rebuilding some of the adjacent lines to double circuit with the new 500kV line to conserve right-of-way.

- Construct a new Pearl 500kV bay to terminate the new 500kV line

Additional improvements which may be included in the plan of service:

<u>Thermal violations related to load service problems</u>

- The Paul-Pearl plan of service does not mitigate any of the load service issues which were also identified with the Paul-Troutdale plan of service
    - Upgrade the (BPA) Forest Grove-Keeler 115kV line to 925Amp capacity
    - Upgrade sections of the (BPA) Keeler-St. Johns 115kV line to 950 Amp capacity
    - Upgrade (PGE) Orenco-Sunset 115kV line to 700 Amp capacity
    - Upgrade the (PAC) St. Johns-Columbia 115kV line to 1400Amp capacity
    - Upgrade the (BPA & CCPUD) Longview-Cardwell-Lexington 115kV line loop
    - Upgrade the (PGE) Sherwood-Tualatin-Durham 115kV line to 1100Amp capacity
- For the Paul-Troutdale plan of service some load service problems were made worse by connecting a new 500kV line into Troutdale. The Paul-Pearl plan of service does not aggravate these overloads. However, the following line and transformers may overload due to local area load growth.
    - (PAC) Troutdale-Gresham 230kV line
    - (PGE) Blue Lake 230/115kV transformer
    - (PAC) Harrison-Lincoln 115kV line

Transfer Related

- These upgrades are reported in the order needed related to transfers.
    - Upgrade the (PAC) Merwin-View-Cherry 115kV line to 1000Amp capacity
    - Upgrade the (BPA) Allston-Rainier-Goble 115kV line to 900Amp capacity
    - Upgrade the (BPA) Longview-Chehalis 230kV line from Longview to the tap, approximately 2 miles, to 2140Amp capacity.
    - Re-sag the (BPA) Napavine-Allston 500kV line section from approximately 5.55 miles south of Napavine substation, structure 7/1, to

the new 500kV substation 12 miles north of Allston substation for 100° C operation.

- Re-sag the (PGE) St. Mary's-Trojan 230kV line for 1400 Amp capacity

Study Results (Alternative #3)

The study results show the main advantage of the Paul-Pearl plan of service is the plan mitigates the line fault and 500kV breaker failure at Pearl, which yields a significant increase in Keeler-Pearl path capacity over the Paul-Troutdale plan of service. The increase can also be accomplished with the Paul-Troutdale plan of service by including a line re-termination at Pearl to eliminate the critical breaker failure. The Paul-Pearl plan of service does not aggravate existing thermal problems in the Troutdale area. However, other facilities will exceed their thermal limits with the Paul-Pearl plan of service and limit the new ATC to approximately the same levels seen with the Paul-Troutdale plan of service.

Summary of Performance with the Paul-Pearl Plan of Service

The Paul-Pearl plan of service had similar performance to Paul-Troutdale. However, a new Paul-Pearl 500kV line was not recommended due to the potential for greater environmental impact, high cost of land through the city of Portland, and increased cost due to a longer alternate route length. Overall, it is expected that this would be a more costly alternative with no additional benefits gained.

D. Additional System Reinforcements

This section lists other facility upgrades that are needed, based on study results, in the I-5 corridor vicinity.

Upgrades listed as transfer related were identified based on the facility having an Outage Transfer Distribution Factor (OTDF) greater than 1.5% with respect to

north to south transfers. Load service upgrades were identified based on OTDF values less than 1.5%.

Transfer Related

- Upgrade the (PAC) Merwin-View-Cherry 115kV line to 1000Amp capacity
    - The Merwin-View-Cherry 115kV line is in parallel to BPA's 500 and 230 kV system, with multiple outages causing overloads
    - The Merwin-View-Cherry 115kV line may exceed its thermal limit with all lines in service with Kalama on-line
    - Ramping Merwin and/or Yale generation may not be fast enough to prevent a sag violation.
    - The upgrade is required to gain additional capacity with the new 500kV line

- Re-terminate the (BPA) Keeler-Pearl 500kV line into a newly developed (BPA) Pearl 500kV bay
    - Eliminates double 500kV line losses for breaker failure contingencies at Pearl substation

- Upgrade the (PAC) Troutdale-Gresham 230kV line to 1250Amp capacity
    - Terminating the new 500kV line into Troutdale brings more power into Troutdale substation and increases the overloads for certain outages
    - The worst outage is the single line loss of the Troutdale-Linneman 230kV line, which overloads the Troutdale-Gresham 230kV line with the 500kV line in service. The outage loads the line close to its thermal limit with the existing system.

- Upgrade the (PGE) Blue Lake 230/115kV transformer

- The worst outage is a double line loss of Troutdale-Gresham and Troutdale-Linneman 230kV lines. The transformer is heavily loaded during this outage with the existing system. The new 500kV line increases the loading by approximately 50MVA.
- Transformation at Blue Lake requires 450MVA capacity for the worst outage. Another possible solution is to reconfigure the 115kV system served from Blue Lake. Further study is needed.
- In the 2012 cases a new Blue Lake-Gresham 230kV line was modeled. With the new line modeled the Blue Lake-Troutdale 230kV line overloads for the double Troutdale-Gresham and Troutdale-Linneman 230kV line outage. However, the new line offloads the Blue Lake transformer for the same outage.

- Upgrade (PAC) Harrison-Lincoln 115kV line to 850Amp capacity
  - With the existing system the Harrison-Lincoln 115kV line is heavily loaded in the event of a double line loss of Keeler-St. Mary's and St. Mary's-Trojan 230kV lines
  - The thermal violations are an existing problem aggravated by the addition of the Paul-Troutdale 500kV line

<u>Facility upgrades related to local area load service problems</u>

- Upgrade the (BPA) Forest Grove-Keeler 115kV line to 925Amp capacity
  - The Forest Grove-Keeler 115kV exceeds its thermal limit in the event of a double line loss of the Keeler-St. Marys and St. Marys-Trojan 230kV lines
  - The upgrade is needed for load support and new generation in the Longview vicinity.

- Upgrade sections of the (BPA) Keeler-St. Johns 115kV line to 950 Amp capacity

- The Keeler-St.Johns 115kV line exceeds its thermal limit for a Keeler 230kV breaker failure contingency.
- This is an existing problem that is only slightly relieved by the Paul-Troutdale 500kV line.
- A new Keeler-Sunset 230kV line mitigates the overloads.

- Upgrade (PGE) Orenco-Sunset 115kV line to 700 Amp capacity
  - The Orenco-Sunset 115kV overloads in the event of the (PGE) St. Mary's #A 230/115kV transformer outage.
  - The upgrade is needed for load service with the existing system.

- Upgrade the (PAC) St. Johns-Columbia 115kV line to 1400Amp capacity
  - The St. Johns-Columbia 115kV line reaches its thermal limit for the (PGE) Rivergate #1 230/115kV transformer outage
  - The upgrade is needed for load service with the existing system

- Upgrade the (BPA & CCPUD) Longview-Cardwell-Lexington 115kV line loop
  - The worst outages overloading the ends of the Longview-Cardwell-Lexington 115kV line loop are the line fault and 115kV breaker failure contingencies at Longview and Lexington.
  - The upgrade is needed for local area load service.
  - New generation in the Longview area would accelerate the need for this upgrade.

- Upgrade the (PGE) Sherwood-Tualatin-Durham 115kV line to 1100Amp capacity
  - In the event of a line fault and 230kV breaker failure at the (PGE) McLoughlin substation the (PGE) Sherwood-Tualatin-Durham 115kV line exceeds its thermal limit.

- The overload is load service related and slightly relieved with the new 500kV line in service.

VI. Comparison of Alternatives

The lower voltage upgrade plan of service would require approximately 130 miles of line upgrades to accommodate the generation in the queue. The lower voltage upgrade plan of service would be expensive and does not enable any RAS reduction. Also, the lower voltage upgrade plan of service would not reduce losses. Wide spread reactive additions would be required to support voltages in the event the SOCSS is implemented. Operating the system with higher amounts of switched capacitor groups could be difficult to coordinate. Without better mitigation for the voltage stability limits for the South of Napavine path, it would be unlikely the South of Allston path capacity could be fully utilized. Therefore it wouldn't be possible to achieve the full benefit of the upgraded lines.

The Paul-Pearl plan of service would have similar performance to the Paul-Troutdale plan of service, but at a higher cost and potentially higher environmental impact.

The Paul-Troutdale plan of service provides additional thermal capacity and reactive power support to the main grid system by providing a parallel path to the I-5 Corridor 500kV transmission system and reducing system losses. The reduction in system reactive power losses provides voltage support for the main grid system. The Paul-Troutdale plan of service also provides the potential to reduce dependence on RAS generation dropping and SOCSS. Also, the Paul-Troutdale plan of service would accommodate proposed new generation in the area.

VIII Conclusion

BPA currently meets its obligations in the I-5 corridor with the existing transmission system and by utilizing RAS. However, future load growth, new generation interconnections, and proposed changes to reliability criteria may cause the present RAS to be inadequate and require construction of new transmission facilities.

BPA has studied several alternatives to support load growth, transmission request, and accommodate new generation. BPA's recommended plan of service is the Paul-Troutdale 500kV line option because it allows BPA to maintain transmission system reliability, accommodate transmission service requests, interconnect new generation, meet contractual obligations, and potentially reduce dependence on RAS.

The initial stage of the Paul-Troutdale project would increase the South of Napavine and South of Allston path TTC by 704MW and 988MW respectively. Other lower voltage system upgrades may be required with the initial stage of the Paul-Troutdale project. The Paul-Troutdale project would accommodate reduced generation dropping, while allowing generation to integrate into the I-5 Corridor. Elimination of the SOCSS is recommended to reduce the possibility of voltage instability in the Portland/Vancouver load service area that could occur at the higher transfer levels possible with the Paul-Troutdale project in service.

Department of Energy

Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

PUBLIC AFFAIRS

February 3, 2010

In reply refer to: DK-7

Richard van Dijk, VP, Steering Committee
Better Way for BPA
PO Box 863
Yacolt, WA 98675

RE: FOIA #BPA-2010-00629-F

Dear Mr. van Dijk:

This is a final response to your Freedom of Information Act (FOIA) request for information that you made to the Bonneville Power Administration (BPA).

You requested:
A copy of the Draft Planning Report for the I-5 Corridor Reinforcement Project dated September 7, 2007 and the appendices.

Response:
BPA has provided a copy of Appendix A and B in their entirety.

I appreciate the opportunity to assist you with this matter and appreciate your patience. If you have any questions about this letter, please contact Laura M. Atterbury, Freedom of Information Act/Privacy Act Specialist, at 503-230-7305.

Sincerely,

Christina J. Brannon
Freedom of Information Act/Privacy Act Officer

Enclosure: Responsive Documents

Appendix A

N-1 Contingencies

N-1: Alcoa-Ross
N-1: Allston-Beaver
N-1: Allston-Driscoll
N-1: Allston-Driscoll T
N-1: Allston-Keeler 500*
N-1: Allston-Longview #1 230
N-1: Allston-Longview #2 230
N-1: Allston-Longview #3 230
N-1: Allston-Longview #4 115
N-1: Allston-Station X 500
N-1: Allston-Trojan #1
N-1: Allston-Trojan #2
N-1: Alvey-Dixonville 500
N-1: Alvey-Marion 500
N-1: Ashe-Hanford 500
N-1: Ashe-Marion 500 *
N-1: Ashe-Slatt 500
N-1: Big Eddy-McLoughlin 230
N-1: Big Eddy-Ostrander 500 *
N-1: Bonneville-Sifton #1
N-1: Bonneville-Sifton #2
N-1: Bonneville-Troudale #1
N-1: Bonneville-Troutdale #2
N-1: Buckley-Grizzly 500
N-1: Buckley-Marion 500 *
N-1: Carlton-Cascade T
N-1: Carlton-Tillamook
N-1: Carver-Gresham
N-1: Carver-McLoughlin
N-1: Cascade T-Sherwood
N-1: Cascade T-Windishar
N-1: CATHLAMET TAP OUTAGE
N-1: Chehalis-Covington
N-1: Chehalis-Holcomb
N-1: Chehalis-Longview
N-1: Chehalis-Longview #1 breaker open at Chehalis
N-1: Chehalis-Longview #3 breaker open at Chehalis
N-1: Chehalis-Olympia
N-1: Chehalis-Raymond
N-1: Chehalis-S.Tacoma Switch Yard
N-1: Clatsop-Driscoll T
N-1: Cosmopolis-Aberdeen
N-1: Cosmopolis-Raymond
N-1: Cowlitz-S.Tacoma Switch Yard Tap
N-1: Dixonville-Meridian 500
N-1: Driscoll to Driscoll T
N-1: Gresham-Linneman
N-1: Gresham-Troutdale
N-1: Holcomb-Naselle
N-1: John Day-Big Eddy #1 500
N-1: John Day-Big Eddy #2 500
N-1: John Day-Marion 500 *

N-1: Keeler-Pearl 500*
N-1: Keeler-Rivergate
N-1: Keeler-St Marys
N-1: KFalls-Meridian 500
N-1: Lexington-Longview
N-1: Lexington-Woodland T
N-1: Marion-Lane 500 *
N-1: Marion-Santiam 500
N-1: McLoughlin-Monitor
N-1: McLoughlin-Pearl
N-1: McLoughlin-Pearl-Sherwood
N-1: McNary-Ross
N-1: Olympia-Grand Coulee 345
N-1: Olympia-S.Elma 115
N-1: Ostrander-McLoughlin 500
N-1: Ostrander-Pearl 500
N-1: Ostrander-Troutdale 500
N-1: Parkdale-Troutdale
N-1: Paul-Allston 500
N-1: Paul-Napavine 500
N-1: Paul-Olympia 500
N-1: Paul-Satsop 500
N-1: Pearl-Marion 500 *
N-1: Pearl-Sherwood
N-1: Raver-Covington #1 500
N-1: Rivergate-Harborton-Trojan
N-1: Ross-Hazell Dell
N-1: Ross-Lexington
N-1: Ross-Rivergate
N-1: Ross-Sifton #1
N-1: Ross-Sifton #2
N-1: Ross-St Johns
N-1: Ross-Woodland T
N-1: S.Elma-Satsop Park
N-1: S.Tacoma Switch Yard-Covington
N-1: S.Tacoma-Cowlitz
N-1: S.Tacoma-Olympia
N-1: S.Tacoma-White River
N-1: Satsop Park-Cosmopolis
N-1: Satsop-Aberdeen #2
N-1: Satsop-Olympia #2 230
N-1: Satsop-Olympia #3 230
N-1: Schultz-Wautoma 500
N-1: Sherwood-Murray H #1
N-1: Slatt-Buckley 500
N-1: Slatt-John Day 500
N-1: Southwest-Cowlitz #3
N-1: St Helens-Allston
N-1: St Helens-Harborton
N-1: St Helens-St Johns
N-1: St Johns-Keeler 115
N-1: St Marys-Murray H

N-1: St Marys-Trojan
N-1: Tacoma-Covington #3
N-1: Tacoma-Cowlitz
N-1: Tacoma-Southwest
N-1: Troutdale-Bluelake
N-1: Troutdale-Linneman
N-1: Wautoma-John Day 500
N-1: Wautoma-Ostrander 500 *
T-1: Alcoa 230/115
T-1: Allston 230/115
T-1: Allston 500/230 #1
T-1: Allston 500/230 #2
T-1: Big Eddy 500/230 #2
T-1: Big Eddy 500/230 #5
T-1: Bluelake 230/115
T-1: Carlton 230/115
T-1: Carver 230/115
T-1: Chehalis 230/115
T-1: Clatsop 230/115
T-1: Covington 500/230 #4
T-1: Covington 500/230 #5
T-1: Custer 500/230 #1
T-1: Custer 500/230 #2
T-1: Custer/PortalW 230/115
T-1: Gresham 230/115 #2
T-1: Gresham 230/115#1
T-1: Keeler 230/115 #1
T-1: Keeler 230/115 #2
T-1: Keeler 500/230
T-1: Lexington 230/115
T-1: Longview 230/115
T-1: Maple Valley 345/230
T-1: Maple Valley 500/230
T-1: McLoughlin 230/115 #1
T-1: McLoughlin 230/115 #2
T-1: McLoughlin 230/115 A
T-1: McLoughlin 230/115 B
T-1: McLoughlin 500/230
T-1: Monroe 500/230
T-1: Murray 230/115
T-1: Murray H 230/115
T-1: Olympia 300/230
T-1: Olympia 500/230
T-1: Paul-Tono 500/115
T-1: Pearl 500/230 #1
T-1: Pearl 500/230 #2
T-1: Rivergate 230/115 #1
T-1: Rivergate 230/115 #2
T-1: Ross 230/115 #1
T-1: Ross 230/115 #2
T-1: Ross 345/230
T-1: Satsop 500/230

T-1: Sherwood 230/115 #1
T-1: Sherwood 230/115 #2
T-1: Sifton 230/115 #1
T-1: Sifton 230/115 #2
T-1: St Johns 230/115
T-1: StMarys 230/115 A
T-1: StMarys 230/115 B
T-1: StMarys 230/115 C
T-1: Tacoma 500/230
T-1: Tacoma N E 230/115 #1
T-1: Tillamook 230/115
T-1: Troutdale 500/230

Appendix A

N-2 Contingencies

BF A1264 DRISCOLL 230 - LINE TO CLAT
BF A1268 DRISCOLL 230 - OTHER LINE
BF A213 LEXINGTN 230 - FLT ANY LINE
BF A315 CARLTON 230 - FLT ANY LINE
BF ALLSTON 115
BF ALLSTON 230 DRIS TP LN
BF ALLSTON 230 EAST BUS
BF ALLSTON 230 WEST BUS
BF B126 RAYMOND 115
BF BONNVILE 230 - BUS
BF BONNVILE 230 - Ross #1
BF BONNVILE 230 - Ross #2
BF CARDWELL 115
BF CHEHALIS 115 - FAULT ANY LINE
BF CHEHALIS 230 - FAULT ANY LINE
BF CHEMAWA 230
BF COWLITZ CCP 115
BF HANNA 230 - FAULT ANY LINE
BF KEELER 115 East
BF KEELER 115 West
BF KEELER 230 - FAULT ANY LINE
BF LEXINGTN 115
BF LONGVIEW 115
BF LONGVIEW 230 N + ANNEX (SUM)
BF LONGVIEW 230 S, CHEH LN
BF LONGVIEW 230 S, OTHER LN
BF MCLOUGLN 230 - FAULT ANY LINE
BF NASELLE 115
BF OREGON CITY 115
BF PEARL 230 - East
BF PEARL 230 - East- Flt McLoughlin
BF PEARL 230 - West
BF RAYMOND 115 - FAULT ANY LINE
BF ROSS 115
BF ROSS 230 E BUS, FLT BONN #2
BF ROSS 230 E BUS, FLT LEX LINE
BF ROSS 230 E BUS,FLT OTHER LINE
BF ROSS 230 W BUS, FLT BONN #1
BF ROSS 230 W BUS,FLT OTHER LINE
BF SANTIAM 230 (BUS SECT BKR)
BF SHERWOOD 230 FLT ANY LINE
BF SIFTON 1 230 FLT ANY LINE
BF SIFTON 2 230 FLT ANY LINE
BF TROJAN 1 230
BF TROJAN 2 230
BF TROUTDAL 230 E BUS
BF TROUTDAL 230 W BUS
BF TROUTDAL 230 W BUS, GRES LINE
BF TROUTDAL 230 W BUS,LINN LINE
BF: 4280 KEELER-PEARL/WEST TX*
BF: 4283 KEELER-PEARL-OSTRNDER*
BF: 4287 OST-PEARL-500/230 TX

BF: 4324 Keeler Flt 500/230tx*
BF: 4394 ALLSTON-KEELER-PEARL*
BF: 4502 NAPA-ALLS-KEELER (GD)*
BF: 4540 NAPAVINE-PAUL-SATSOP
BF: 4542 NAPA-PAUL-CENT G1 + BH
BF: 4548 ALLSTON-PAUL-SATSOP
BF: 4550 OLY-PAUL-ALLSTON
BF: 4554 OLYMPIA-PAUL-TONO
BF: 4690 PAUL-ALLSTON-TX #2
BF: 5232 Napavine
L/D ALL-DRSCLT/ALLS-DRISCOLL (74)
L/D ALLS-ASTOR-NASELLE 115
L/D ALLST-LONGVIEW 1&2 (101)
L/D ALLST-LONGVIEW 1&3
L/D ALLST-LONGVIEW 1&4
L/D ALLST-LONGVIEW 3&4
L/D ALLSTON-TROJ1, TROJ2 (91)
L/D BONN-TROUT #1&2 (42)
L/D BONN-TRT 2,BON-SIFT TP1 (222)
L/D BON-S TP2-ROS,MCN-ROS M-189 (128)
L/D BON-S TP-ROSS 1 & 2 (24)
L/D BON-SIFT & BON-ALCO 115 M-189 (39)
L/D CARLTON-SHERWOOD 230 3 TERM
L/D CHEHALIS-LONGVW T 1&2
L/D CHEH-LONGVIEW,LEX-LONGV (84)
L/D F GRV-MCMIN & MCMIN-CARL M-153 (161)
L/D GRESH-TRTP2-TRT,LINN-TRTP1-TRT (89)
L/D KEEL-ST M ST M-TROJ1 (221)
L/D MCL-PEARL #-SHERW
L/D PEARL-SHERWOOD 1&2 (111)
L/D ROSS-RVGT,ROSS-ST J (101)
L/D ST M-TROJ1,RIVERGATE-TROJ2 (9)
N-2: Ashe-Marion/Ashe-Slatt
N-2: Ashe-Marion/Buckley-Marion *
N-2: Ashe-Marion/Coyote Springs-Slatt
N-2: Ashe-Marion/John Day-Marion *
N-2: Ashe-Marion/Slatt-Buckley *
N-2: Ashe-Marion/Slatt-John Day
N-2: Big Eddy Ostrander/Wautoma-Ostrander *
N-2: Big Eddy-Celilo #1/Big Eddy-Ostrander
N-2: Big Eddy-Ostrander/Big Eddy-Chemawa 230
N-2: Big Eddy-Ostrander/Big Eddy-Troutdale 230
N-2: Buckley-Marion/John Day-Marion *
N-2: Buckley-Marion/Marion-Santiam *
N-2: John Day-Big Eddy #1 & #2
N-2: John Day-Big Eddy #2/John Day-Marion
N-2: John Day-Marion/Pearl-Marion
N-2: Keeler-Pearl/Big Eddy-Chemawa 230*
N-2: Marion-Alvey/Marion-Lane *
N-2: Marion-Alvey/Marion-Santiam *
N-2: Marion-Santiam + Maion 500 shunt caps *
N-2: Ostrander-McLoughlin/Big Eddy-McLoughlin 230

N-2: Paul-Allston/Allston-Station X*
N-2: Paul-Satsop/Olympia-Satsop 230
N-2: Pearl-Keeler/Pearl-Sherwood 230*
N-2: Pearl-Keeler/Sherwood-Carlton 230*
N-2: Pearl-Marion + Pearl 500 shunt caps *
N-2: Pearl-Ostrander/Big Eddy-McLoughlin 230
N-2: Pearl-Ostrander/Ostrander-McLoughlin
N-2: Tacoma-Raver #1 & #2

Appendix B

Generation Patterns

Generation Patterns

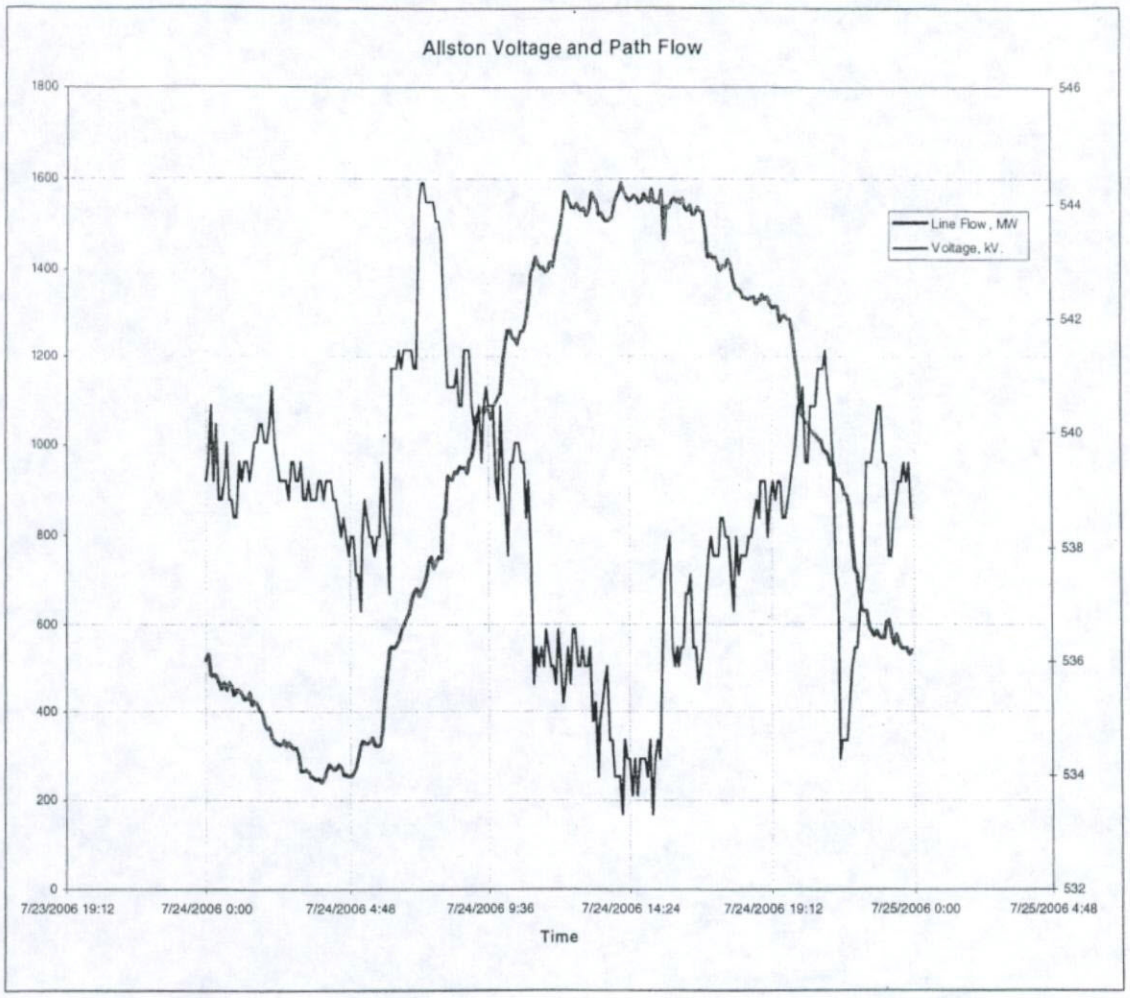
The Willamette Valley/Southwestern Washington (WILSWA) load service area includes the cities of Portland, Salem, and Eugene Oregon and Vancouver Washington. In the past and currently this area has been considered a winter peaking system that may experience voltage instability under high load conditions and certain outages. BPA's Operations currently monitors the area with an indicator that calculates the WILSWA area stress level. From the indicator value the proximity to instability can be determined.

The WILSWA indicator arming levels are as follows:

- WILSWA indicator = 6800MW
    - Indicates risk of voltage instability for common mode outages
- WILSWA indicator = 8400MW
    - Indicates risk of voltage instability for single element outages
- WILSWA indicator = 10300MW
    - Indicates risk of voltage instability with all lines in service

In recent years, some of the load service areas, internal to the WILSWA load service area, have seen the peak summer loads approach peak winter loads. This is most likely due to increase saturation of industrial load and air conditioning. The increased load, coupled with high north to south flows through the I-5 corridor, can lead to a significant voltage depression in the WILSWA area. This behavior has been seen at the Allston 500kV bus. July 24th 2006 is a good example of the voltage behavior at Allston under high north to south flows and area load. Plot #1 below shows the Allston 500kV bus voltage and the Allston-Keeler 500kv line flow. The plot shows a pronounced voltage drop for the duration of the peak loading.

Plot #1



BPA's Operations monitors paths that are internal or serve the WILSWA/I-5 Corridor load service area and key generation to ensure all lines stay within their thermal capabilities and maintain voltage stability. In order to determine thermal capabilities and voltage stability limits, BPA's Operations studies the WILSWA/I-5 Corridor load service area using multiple generation patterns and transfer levels. Key generators varied are as follows:

- Chehalis 520MW
- Beaver 492MW
- River Road 235MW
- Swift 210MW
- Merwin/Yale 130MW

BPA's Operations studies every possible combination of the above units off and on, for a total of 32 generation patterns. These generating patterns are used in the studies for the peak summer season limits for South of Napavine, South of Allston, and Keeler-Pearl paths.

In the I-5 corridor planning study, the multiple generation pattern method was used to determine the best performing plan of service for the I-5 corridor. The methodology was extended to the new generation integrating into the I-5 corridor, for a total of 512 generation patterns studied. The units added were as follows:

- Port Westward 388MW
- Mint farm 248MW
- Grays Harbor/Satsop 628MW
- Kalama 600MW

Typically the generation patterns with all or most generation off-line are the most limiting for thermal and voltage performance criteria. In order to determine whether operating conditions exist where loads are peaking with all or most local I-5 Corridor generation off-line, SCADA data was collected for the WILSWA load service area and the key generators listed above. Determining the load in the WILSWA load service area is important because it represents the major load center affecting the I-5 corridor main grid transmission system and is a useful indicator of the load in the Portland area during the peak summer season. The purpose of gathering the data was to determine if the WILSWA load was high (which is how the load is modeled in the study cases) simultaneous with critical generation patterns.

SCADA Data Collected:

- Five years of peak summer SCADA data
    - Months June 15th to September 15th
    - Years 2002 to 2006
    - Hourly data
- Allston-Keeler 500kV line flows

- Output of existing generation listed above
    - Chehalis 520MW
    - Beaver 492MW
    - River Road 235MW
    - Swift 210MW
    - Merwin/Yale 130MW
    - If output was above 50% of maximum, unit was considered on
- WILSWA load

Use of the SCADA data:

- Each data point is time stamped and contains:
    - WILSWA net load
    - Allston-Keeler 500kV line flow
    - The output of individual generators
- The output of individual generators or group of generators was converted to an On/Off state
- From the On/Off state a generation pattern was identified
    - The patterns are in Table #1 below
- The generation pattern is paired with the like time stamped WILSWA load and Allston-Keeler 500kV line flow
- From the data, the frequency of occurrence of a given generation pattern simultaneous with high WILSWA load and Allston-Keeler 500kV line flows, can be determined.

Table #1

SCADA data analysis case names

Pattern	Chehalis	Beaver	River Rd	Swift	Yale/Merwin
G0	1	1	1	1	1
G1	0	1	1	1	1
G2	1	0	1	1	1
G3	0	0	1	1	1
G4	1	1	0	1	1
G5	0	1	0	1	1
G6	1	0	0	1	1
G7	0	0	0	1	1
G8	1	1	1	0	1
G9	0	1	1	0	1
G10	1	0	1	0	1
G11	0	0	1	0	1
G12	1	1	0	0	1
G13	0	1	0	0	1
G14	1	0	0	0	1
G15	0	0	0	0	1
G16	1	1	1	1	0
G17	0	1	1	1	0
G18	1	0	1	1	0
G19	0	0	1	1	0
G20	1	1	0	1	0
G21	0	1	0	1	0
G22	1	0	0	1	0
G23	0	0	0	1	0
G24	1	1	1	0	0
G25	0	1	1	0	0
G26	1	0	1	0	0
G27	0	0	1	0	0
G28	1	1	0	0	0
G29	0	1	0	0	0
G30	1	0	0	0	0
G31	0	0	0	0	0

Off = 0
On = 1

The scatter plots constructed from the SCADA data were placed in appendix B1. Appendix B1 contains a frequency of generation pattern occurrence at specified WILSWA load levels and Allston-Keeler 500kV line path flows.

Study Results

The base cases used in the I-5 Corridor study had a WILSWA load level of approximately 6300MW. The study results showed most thermal limitations occurred with the Allston-Keeler 500kV line above 1500MW. For purposes of determining critical WILSWA load level and Allston-Keeler 500kV line flows, SCADA data results with the WILSWA load level above 6000MW and Allston-Keeler 500kV line flows above 1500MW were used as the criteria.

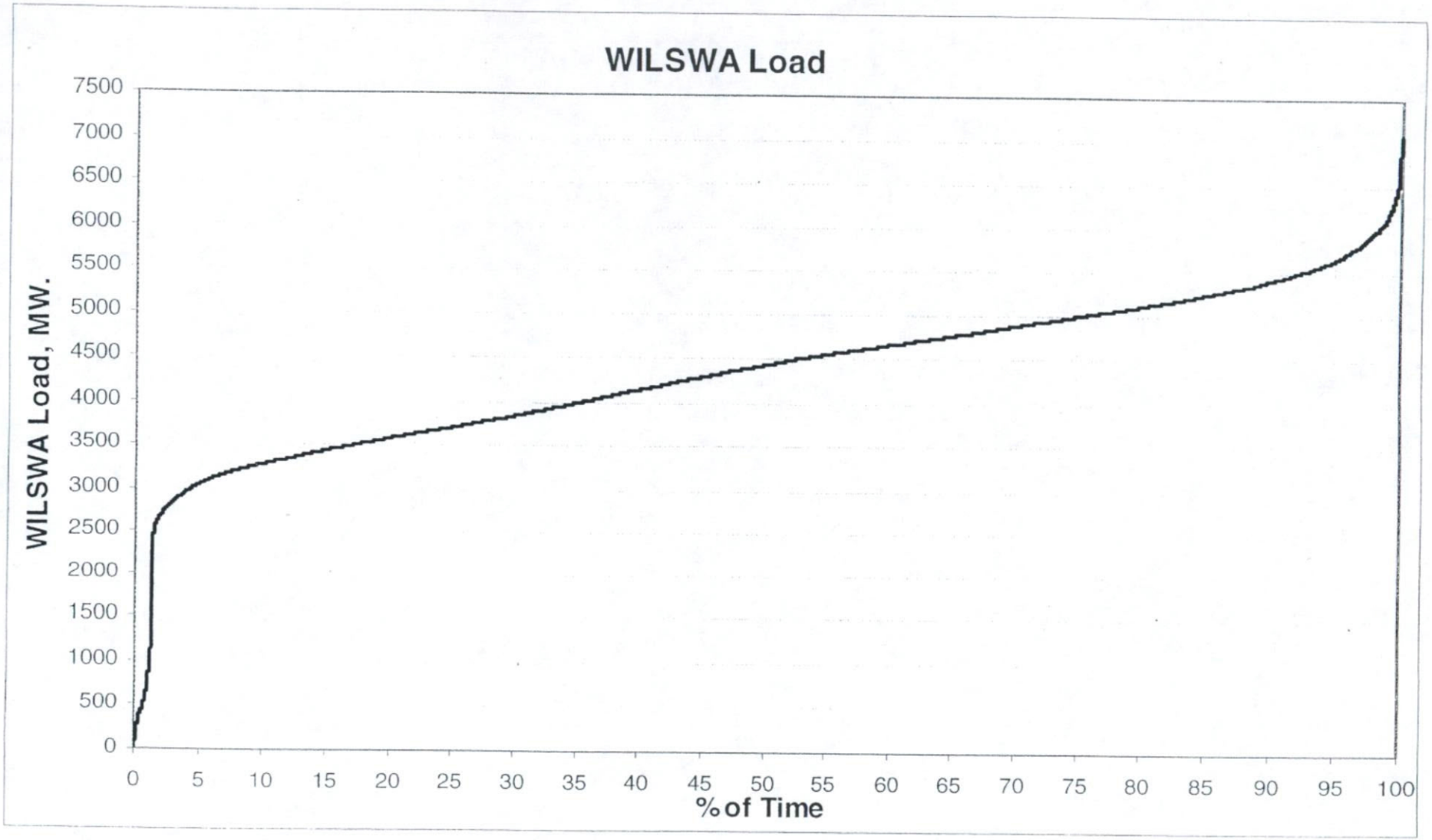
The SCADA data showed the most limiting generation patterns were unlikely to occur during peak summer load conditions in the WILSWA load service area. Appendix B2 shows only patterns G0, G2, G5, G8, G16, and G24 were likely to occur simultaneous with peak loads and transfers. Each of these patterns had most of the I-5 Corridor generation on-line. The conclusion to be drawn from this analysis is that most I-5 Corridor generation is on-line when the WILSWA area load and Allston-Keeler 500kV line flows are high simultaneously.

Appendix B1

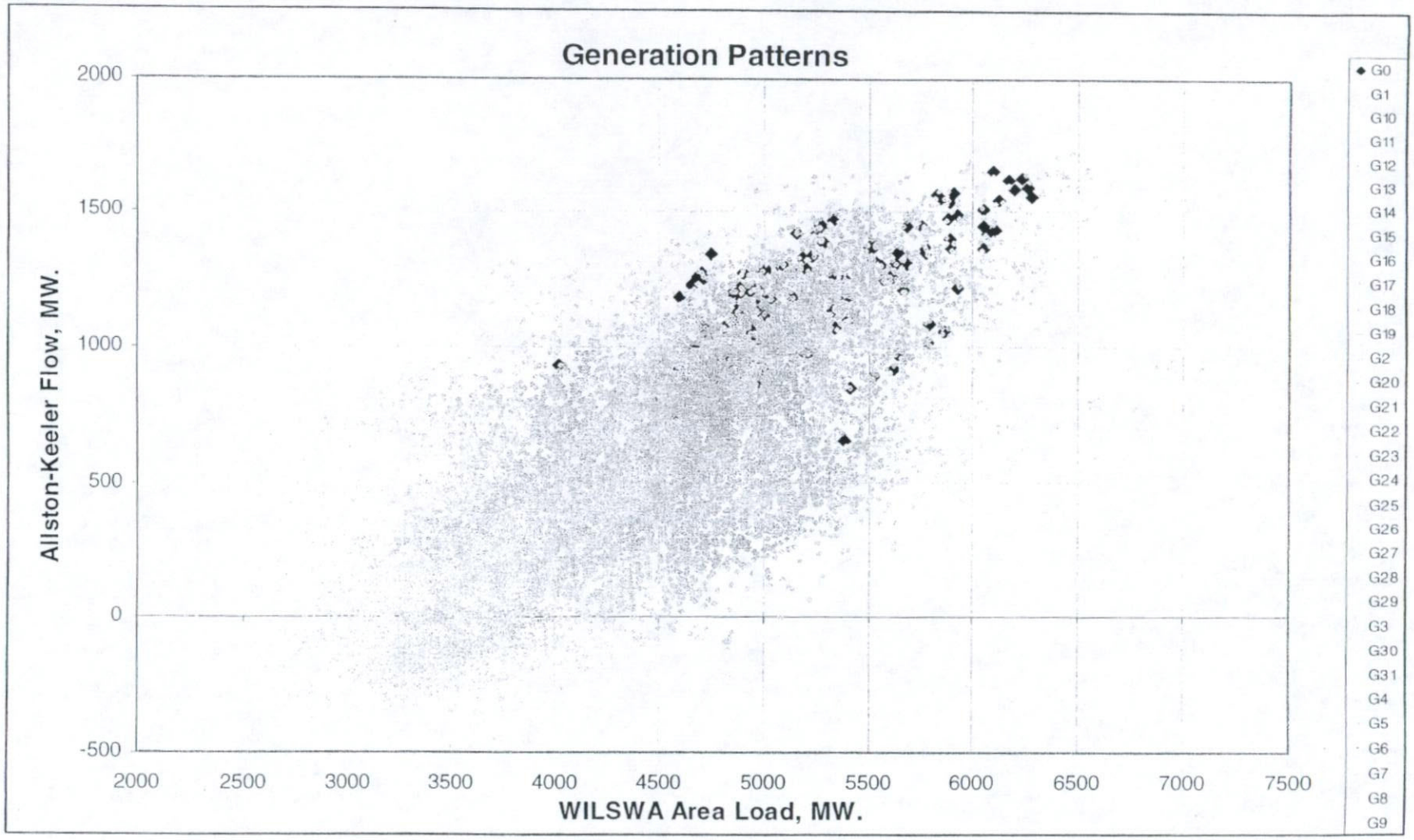
Generation Pattern Plots

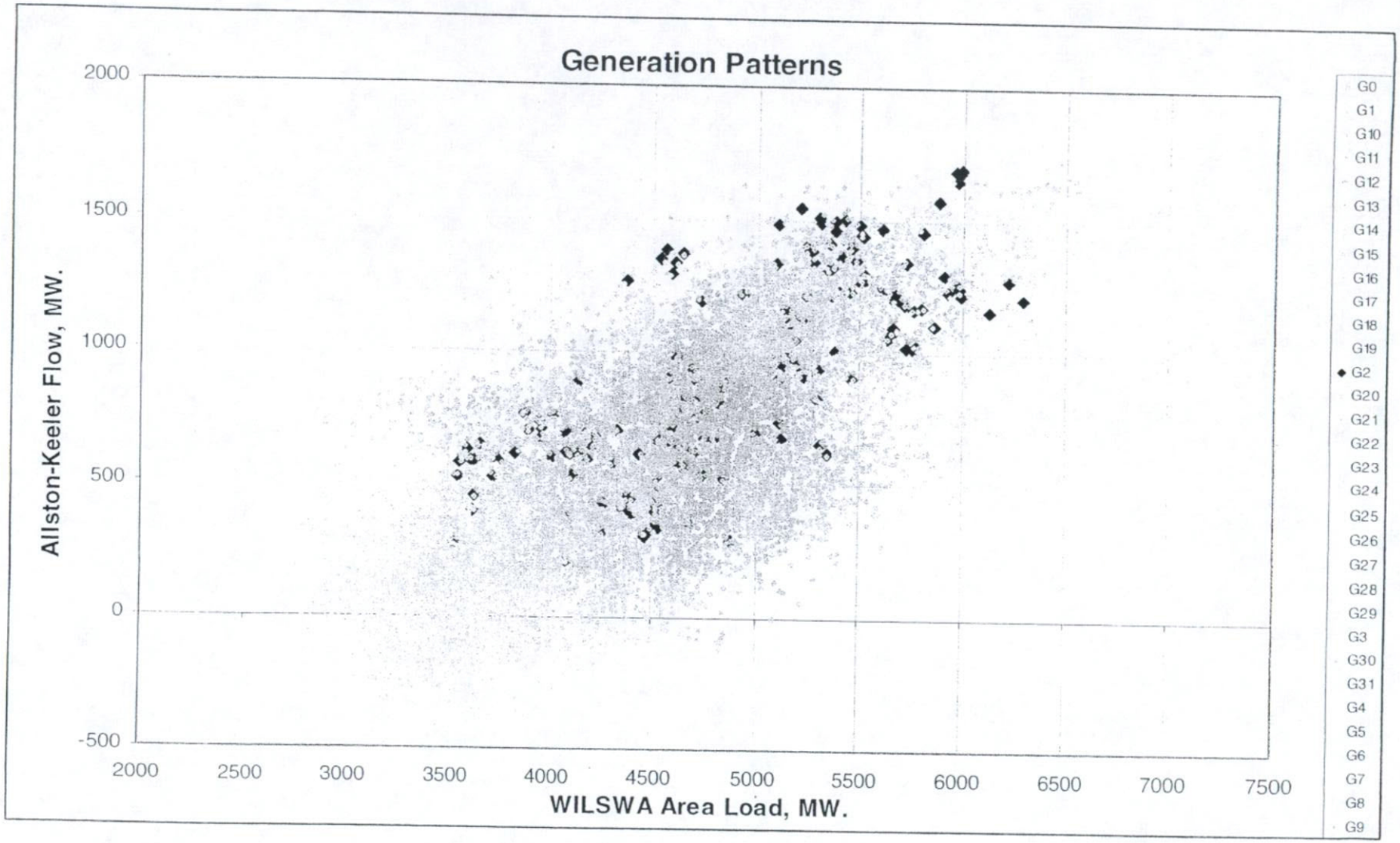
Generation Pattern Plots

WILSWA Load/Allston-Keeler Flow


WILSWA Load
WILSWA Load, MW.
7500
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
% of Time

G0


Generation Patterns
Allston-Keeler Flow, MW.
2000
1500
1000
500
0
-500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
WILSWA Area Load, MW.
G0
G1
G10
G11
G12
G13
G14
G15
G16
G17
G18
G19
G2
G20
G21
G22
G23
G24
G25
G26
G27
G28
G29
G3
G30
G31
G4
G5
G6
G7
G8
G9


Generation Patterns
Allston-Keeler Flow, MW.
2000
1500
1000
500
0
-500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
WILSWA Area Load, MW.
G0
G1
G10
G11
G12
G13
G14
G15
G16
G17
G18
G19
G2
G20
G21
G22
G23
G24
G25
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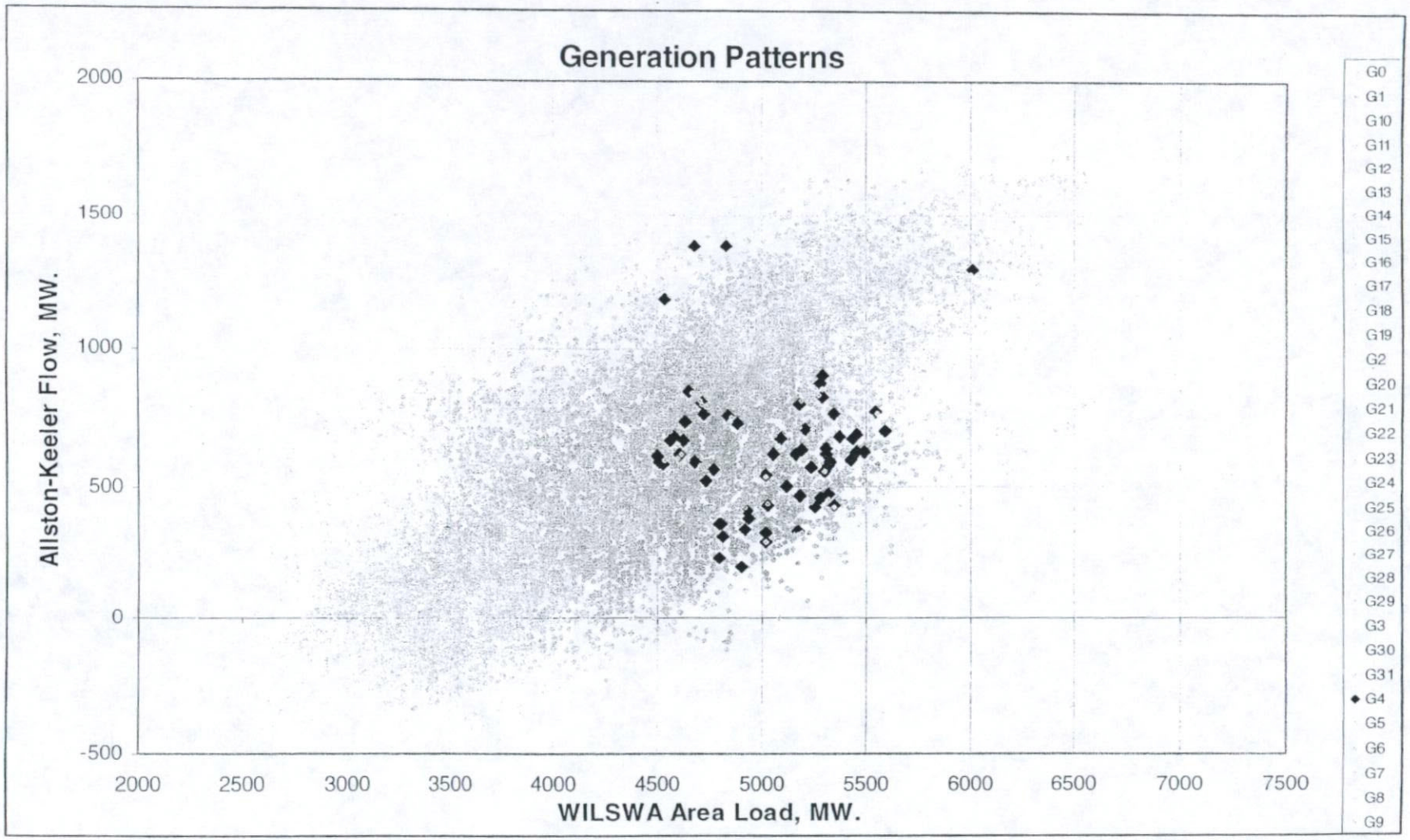
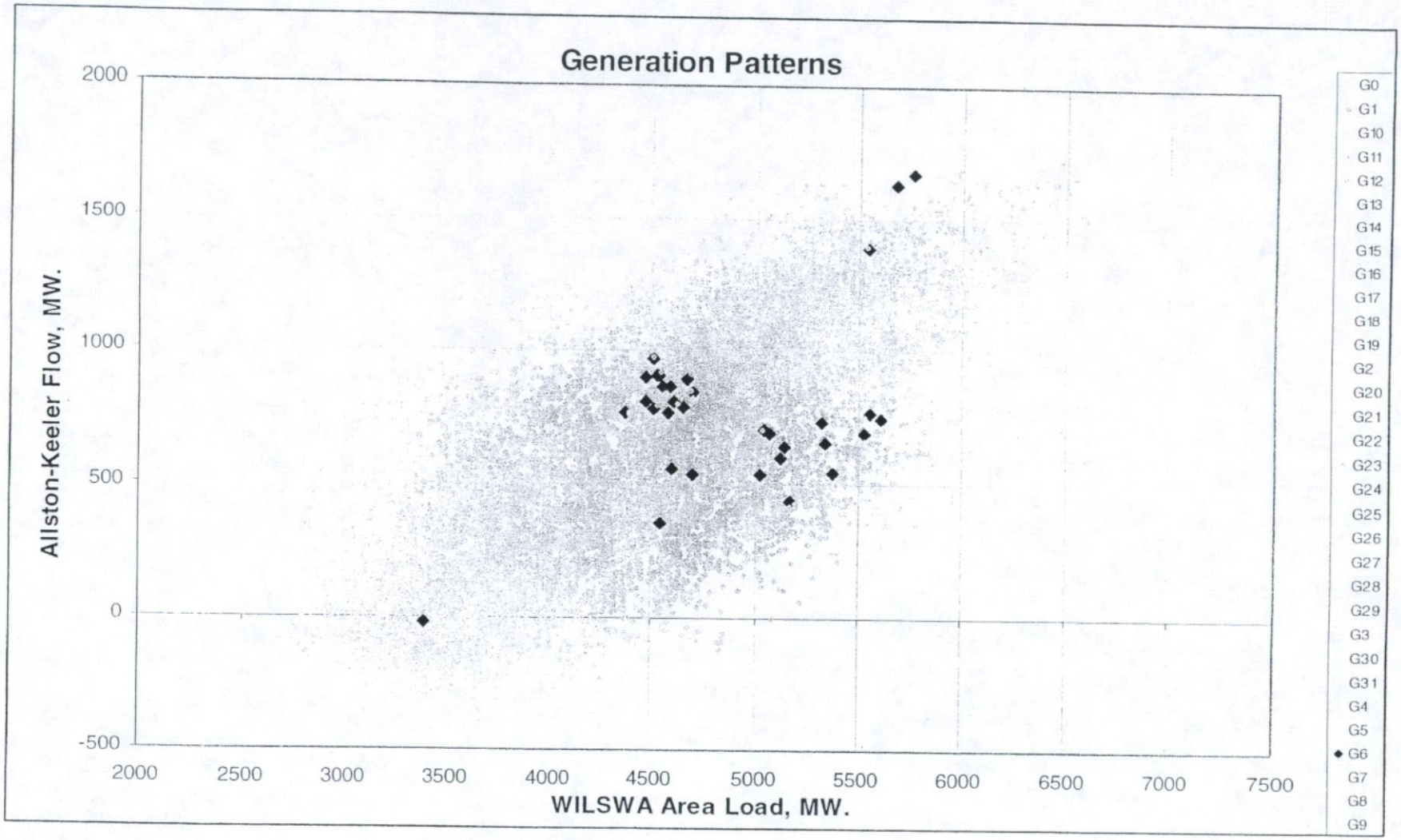
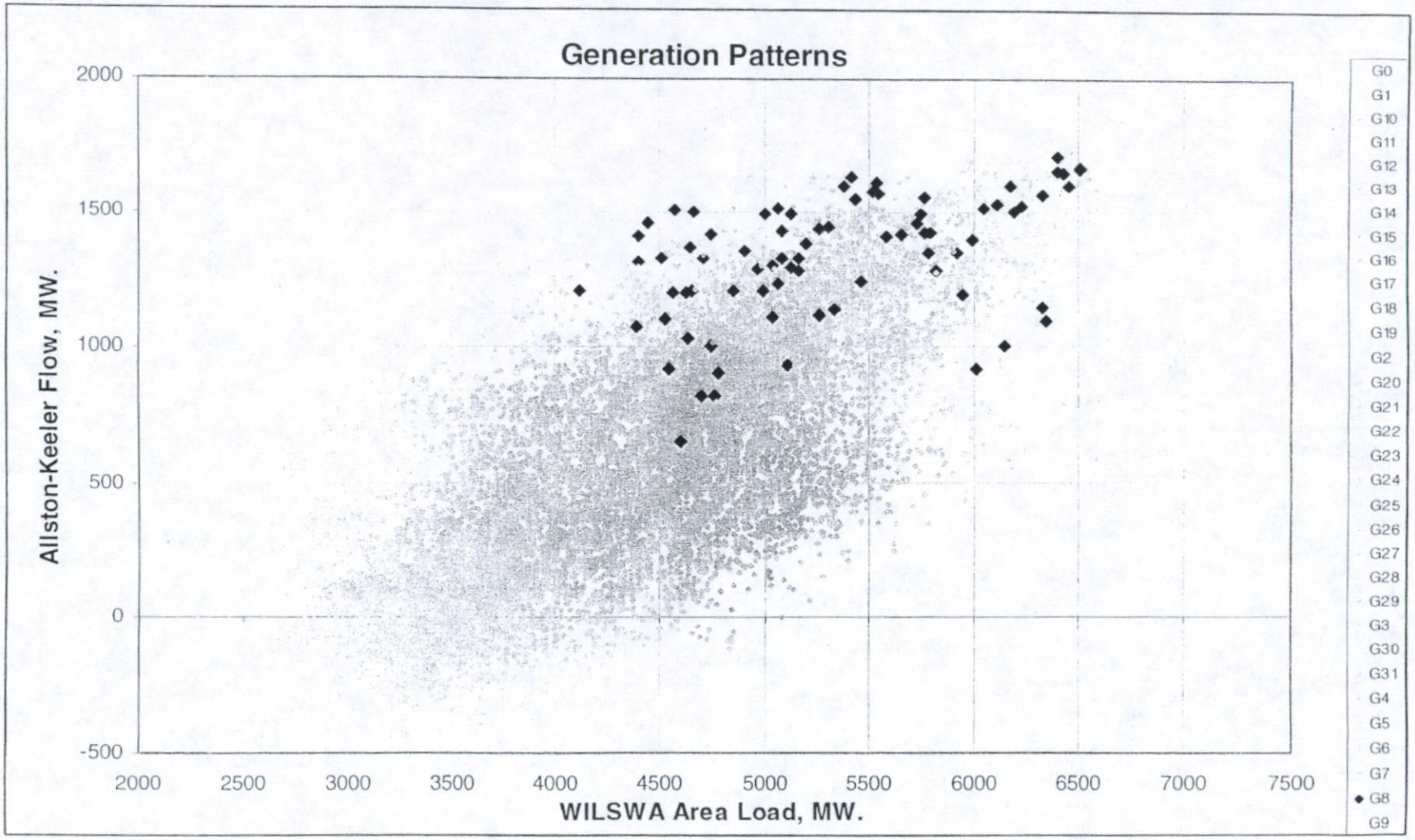
G27
G28
G29
G3
G30
G31
G4
G5
G6
G7
G8
G9

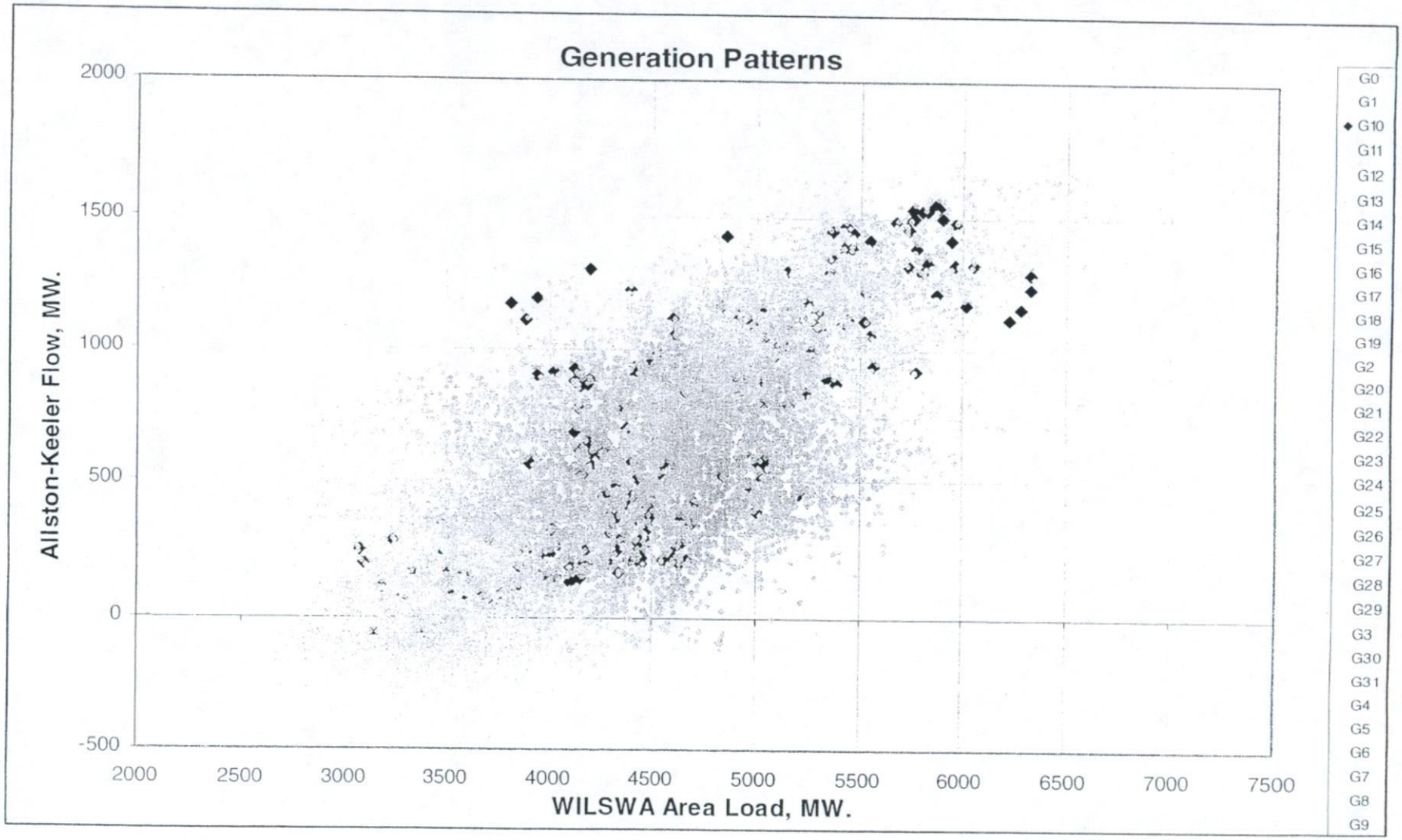

Generation Patterns
Allston-Keeler Flow, MW.
2000
1500
1000
500
0
-500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
WILSWA Area Load, MW.
G0
G1
G10
G11
G12
G13
G14
G15
G16
G17
G18
G19
G2
G20
G21
G22
G23
G24
G25
G26
G27
G28
G29
G3
G30
G31
G4
G5
G6
G7
G8
G9

G6

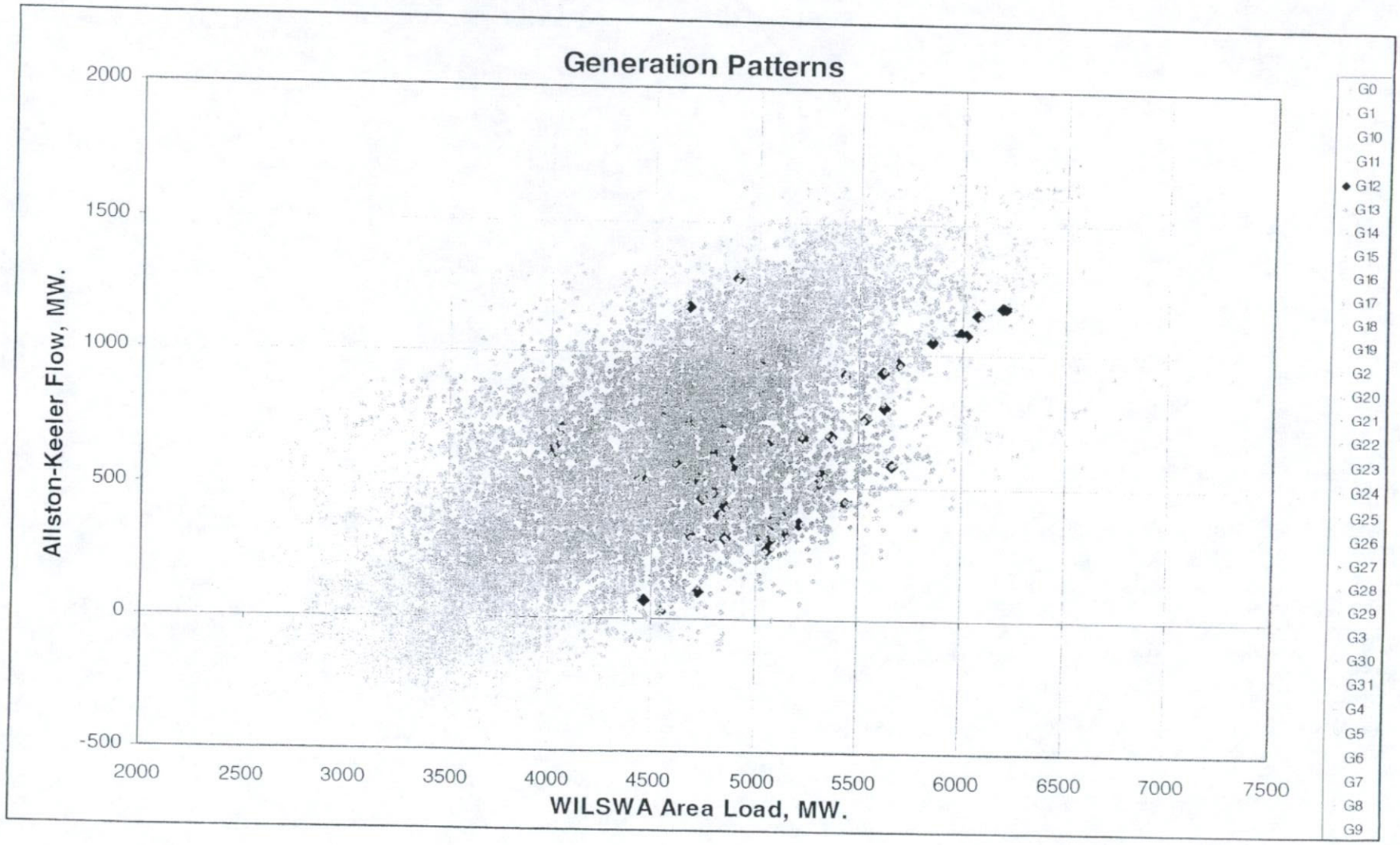

Generation Patterns
Allston-Keeler Flow, MW.
2000
1500
1000
500
0
-500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
WILSWA Area Load, MW.
G0
G1
G10
G11
G12
G13
G14
G15
G16
G17
G18
G19
G2
G20
G21
G22
G23
G24
G25
G26
G27
G28
G29
G3
G30
G31
G4
G5
G6
G7
G8
G9

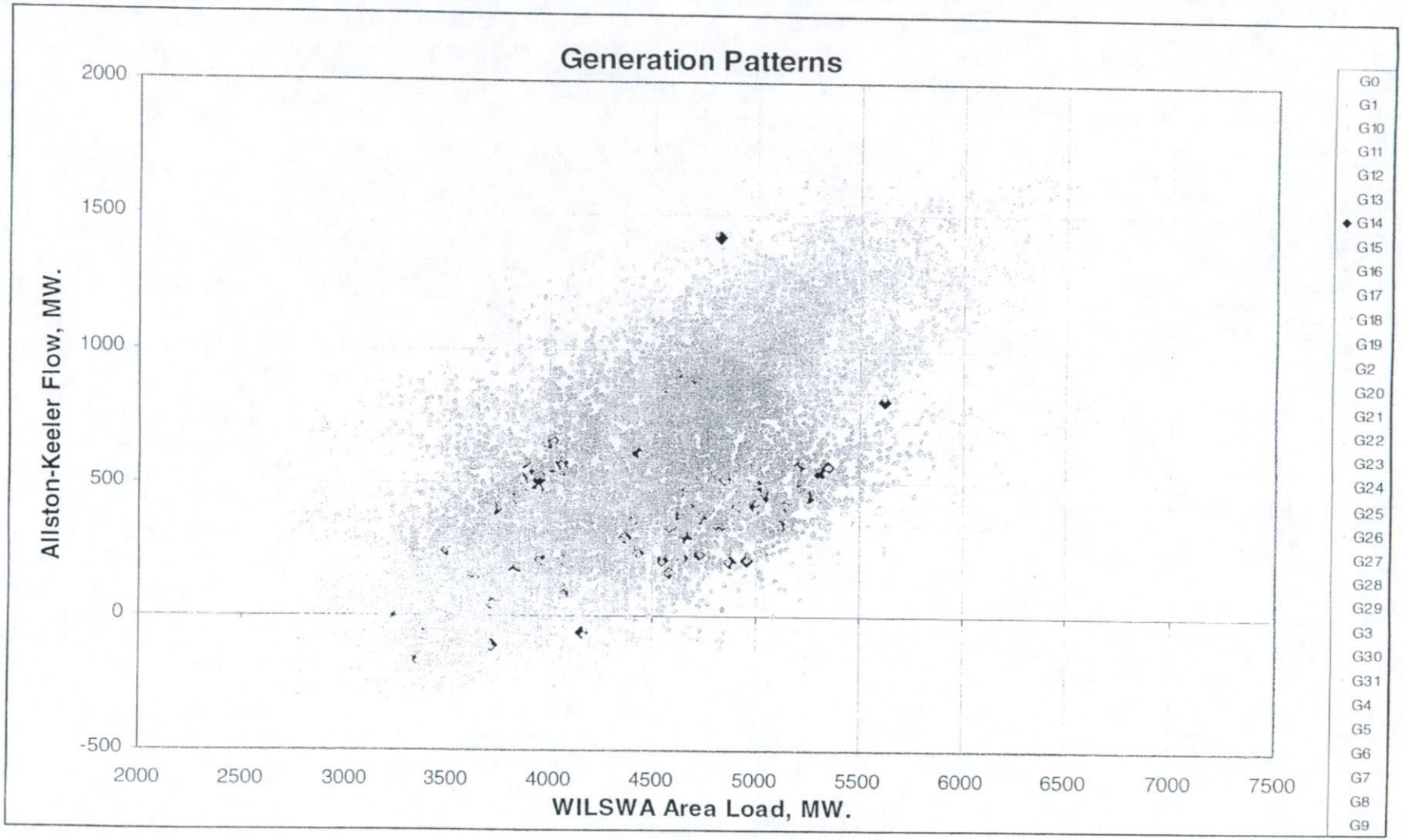

Generation Patterns
Allston-Keeler Flow, MW.
2000
1500
1000
500
0
-500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
WILSWA Area Load, MW.
G0
G1
G10
G11
G12
G13
G14
G15
G16
G17
G18
G19
G2
G20
G21
G22
G23
G24
G25
G26
G27
G28
G29
G3
G30
G31
G4
G5
G6
G7
G8
G9

G10

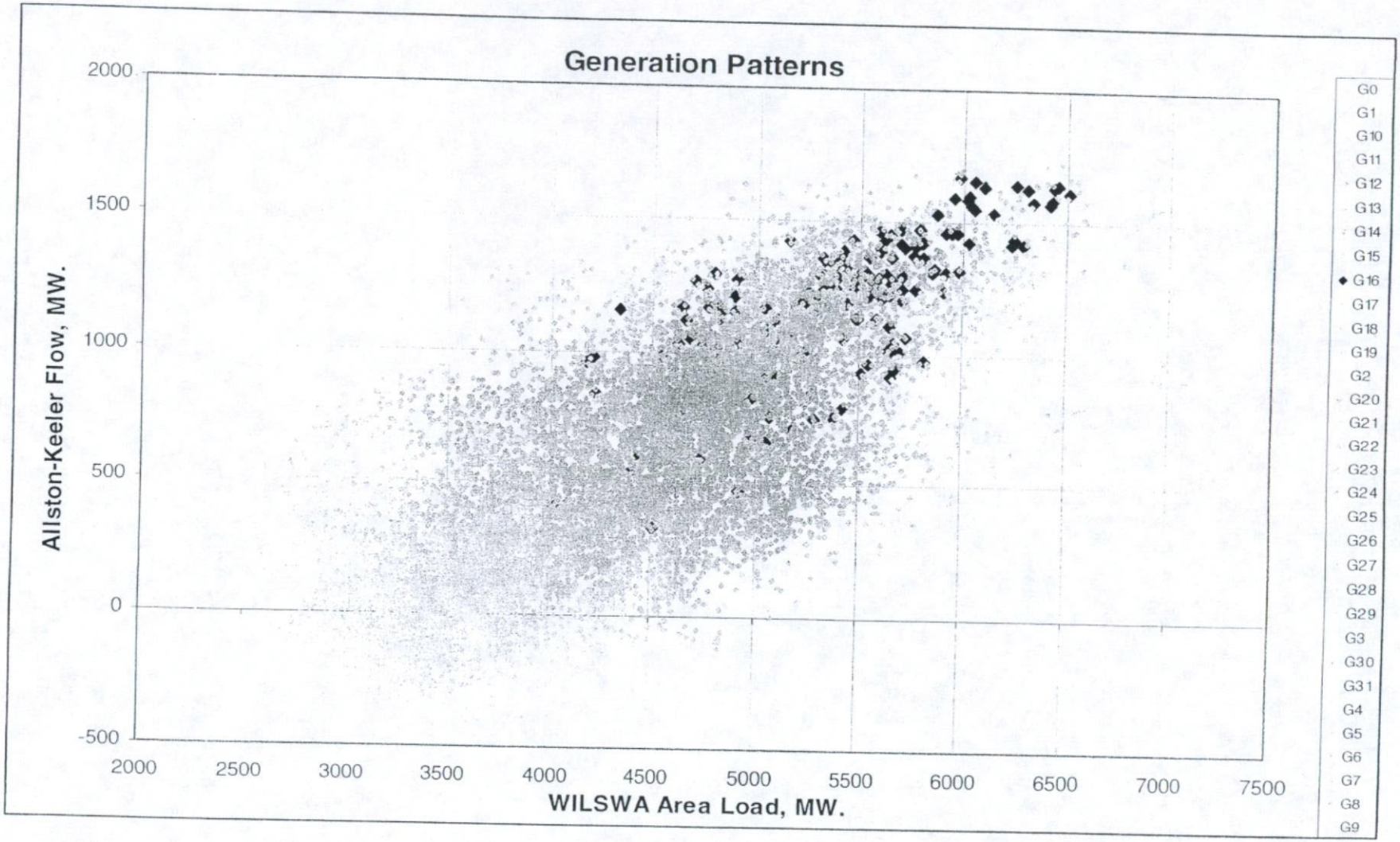

Generation Patterns
Allston-Keeler Flow, MW.
2000
1500
1000
500
0
-500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
WILSWA Area Load, MW.
G0
G1
G10
G11
G12
G13
G14
G15
G16
G17
G18
G19
G2
G20
G21
G22
G23
G24
G25
G26
G27
G28
G29
G3
G30
G31
G4
G5
G6
G7
G8
G9

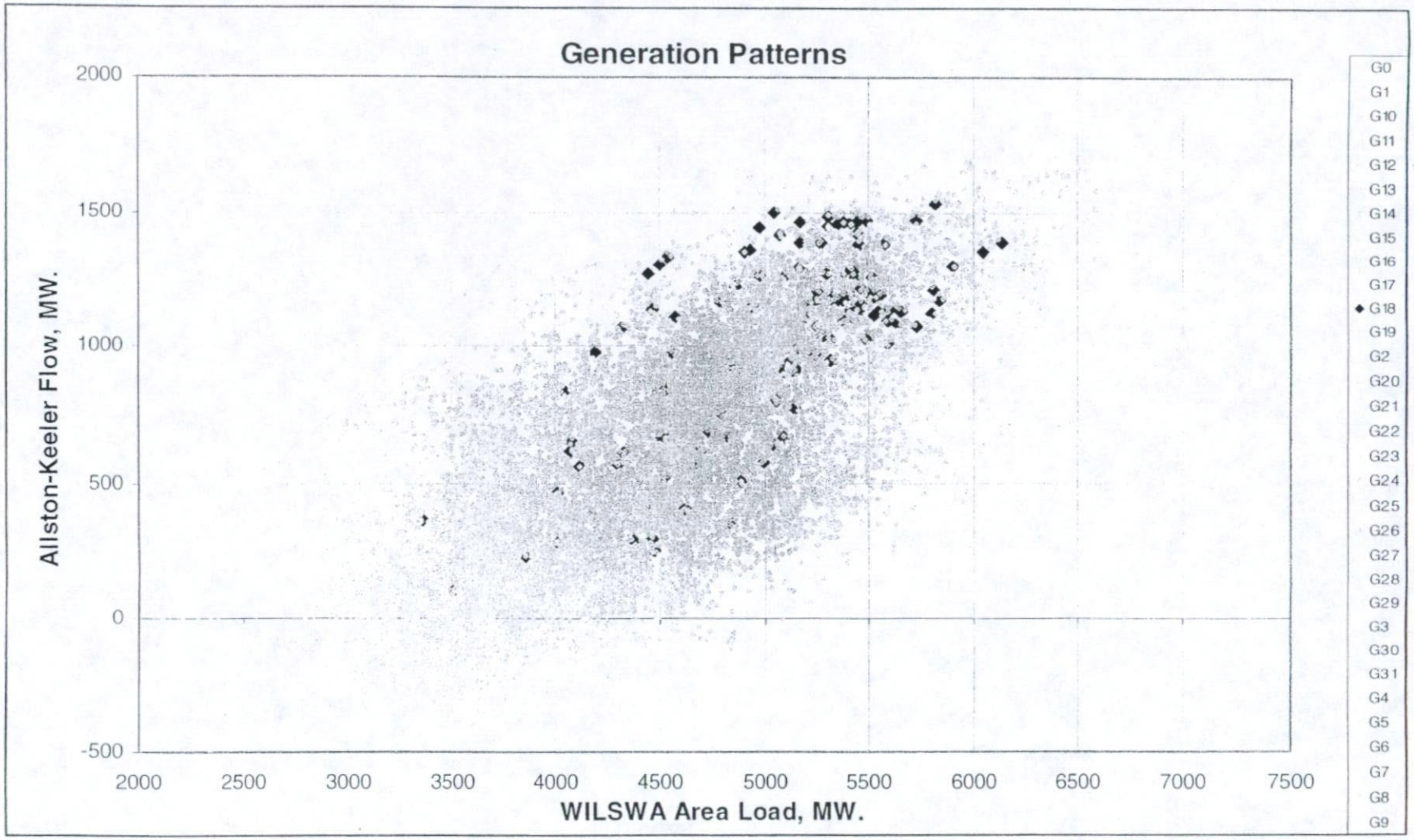
G12

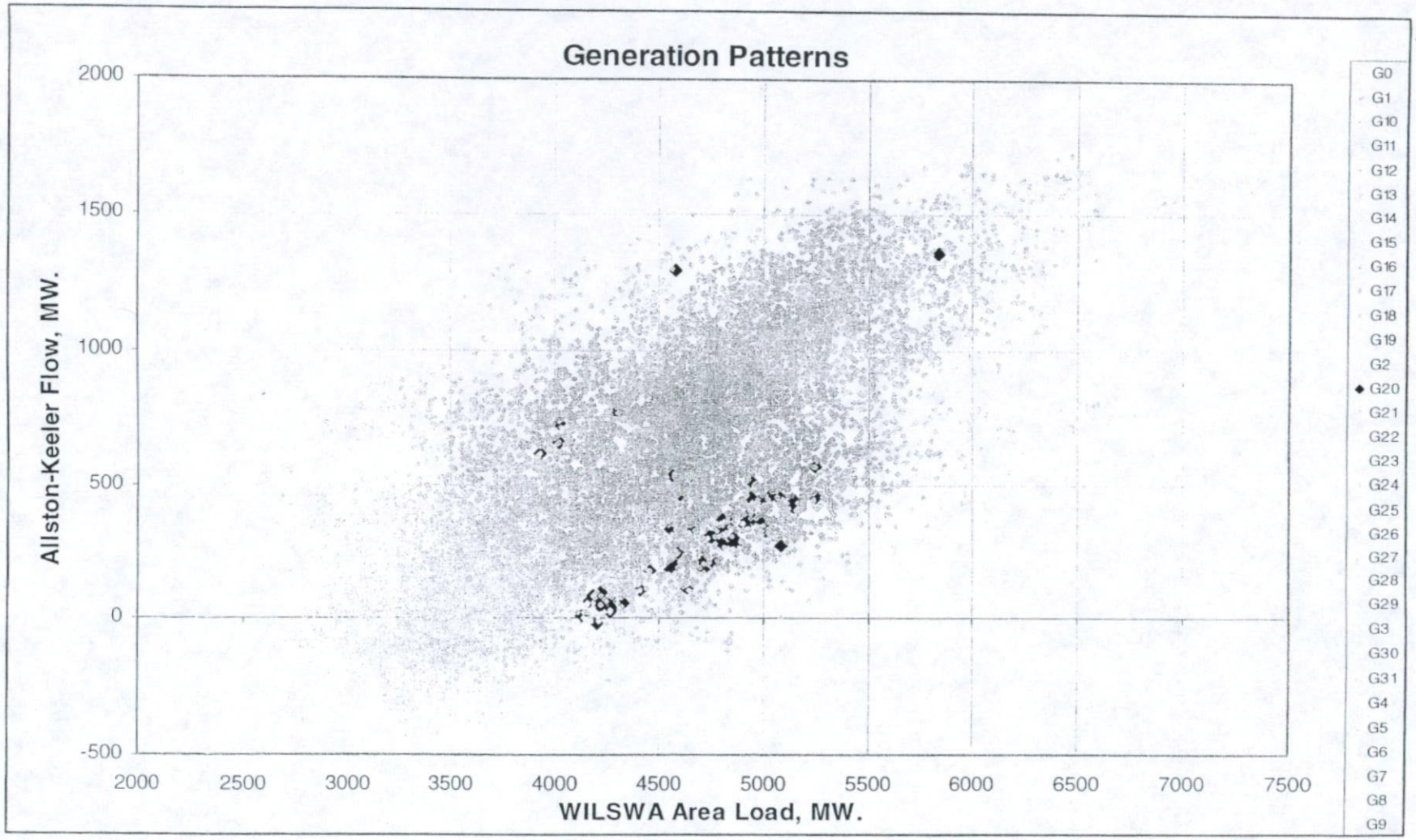

Generation Patterns
Allston-Keeler Flow, MW.
2000
1500
1000
500
0
-500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
WILSWA Area Load, MW.
G0
G1
G10
G11
G12
G13
G14
G15
G16
G17
G18
G19
G2
G20
G21
G22
G23
G24
G25
G26
G27
G28
G29
G3
G30
G31
G4
G5
G6
G7
G8
G9

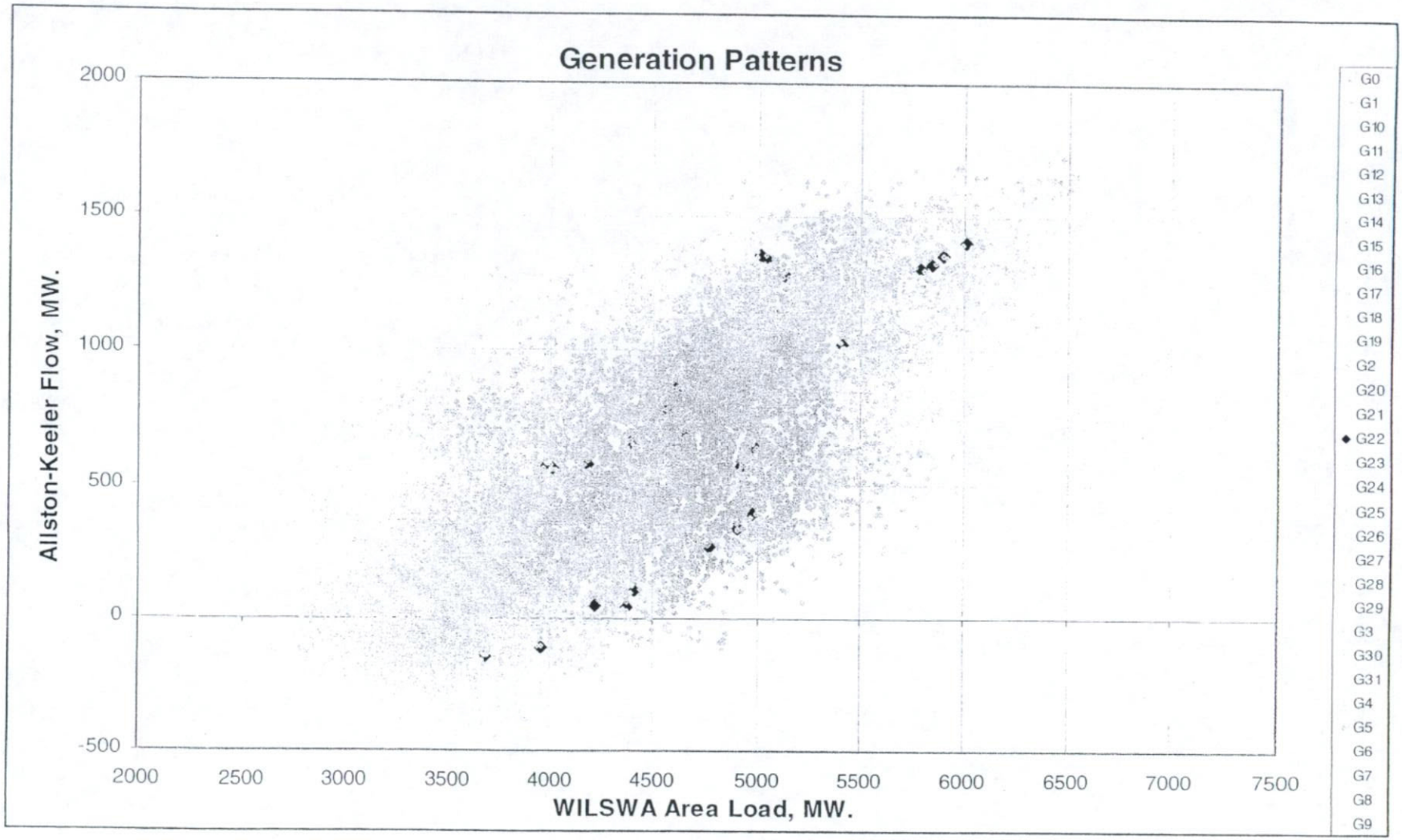

Generation Patterns
Allston-Keeler Flow, MW.
2000
1500
1000
500
0
-500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
WILSWA Area Load, MW.
G0
G1
G10
G11
G12
G13
G14
G15
G16
G17
G18
G19
G2
G20
G21
G22
G23
G24
G25
G26
G27
G28
G29
G3
G30
G31
G4
G5
G6
G7
G8
G9

G16

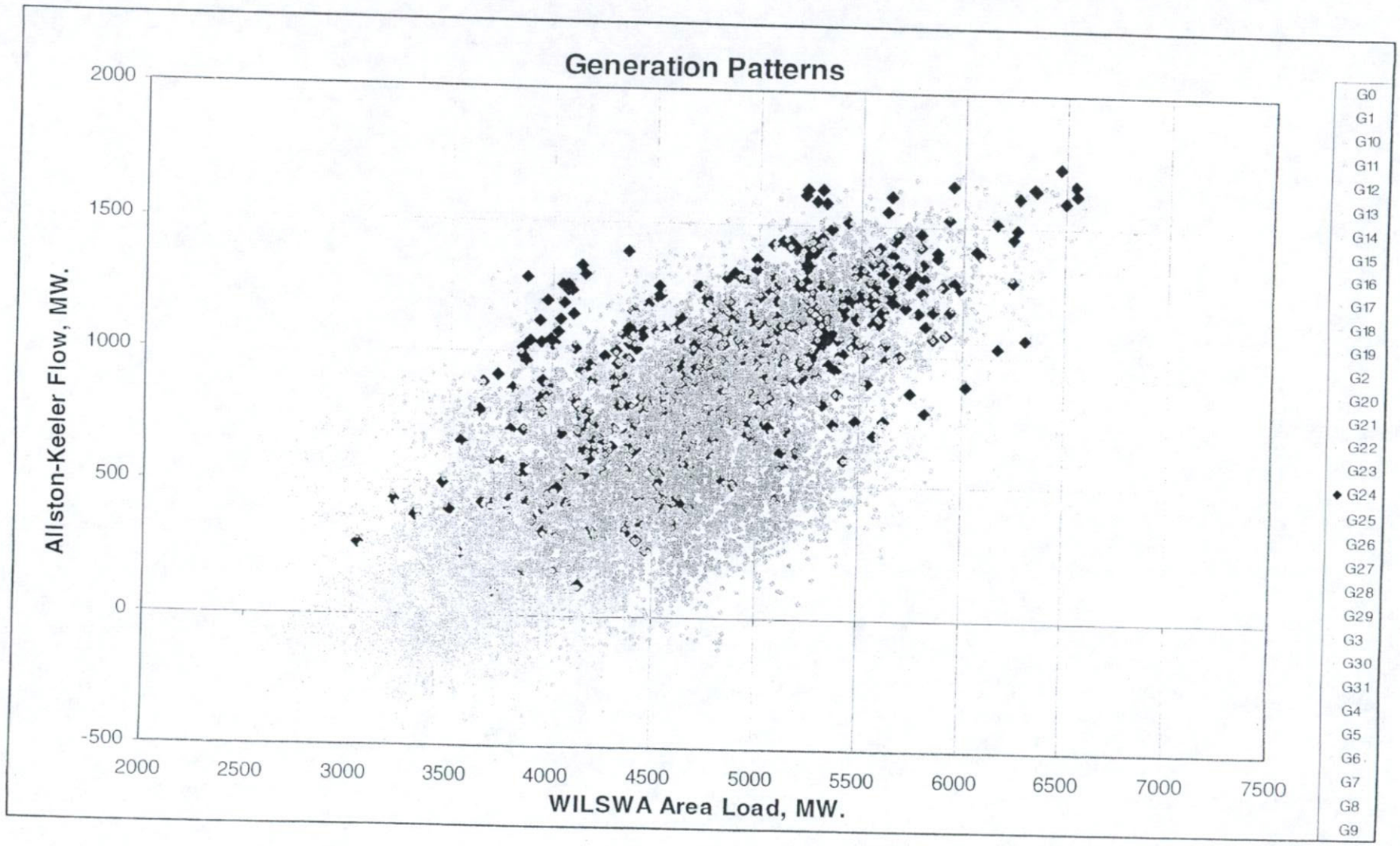

Generation Patterns
Allston-Keeler Flow, MW.
2000
1500
1000
500
0
-500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
WILSWA Area Load, MW.
G0
G1
G10
G11
G12
G13
G14
G15
G16
G17
G18
G19
G2
G20
G21
G22
G23
G24
G25
G26
G27
G28
G29
G3
G30
G31
G4
G5
G6
G7
G8
G9

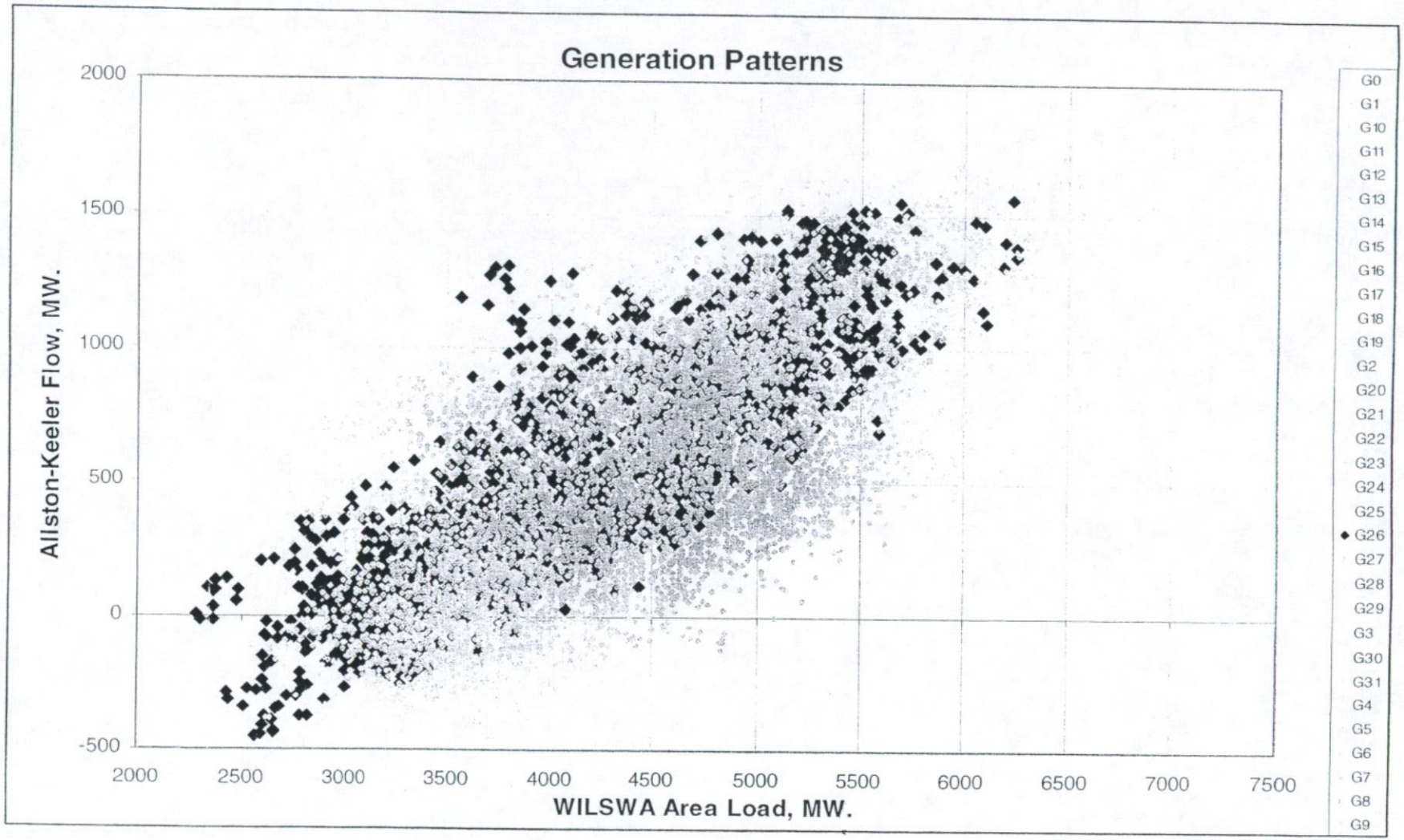

Generation Patterns
Allston-Keeler Flow, MW.
2000
1500
1000
500
0
-500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
WILSWA Area Load, MW.
G0
G1
G10
G11
G12
G13
G14
G15
G16
G17
G18
G19
G2
G20
G21
G22
G23
G24
G25
G26
G27
G28
G29
G3
G30
G31
G4
G5
G6
G7
G8
G9

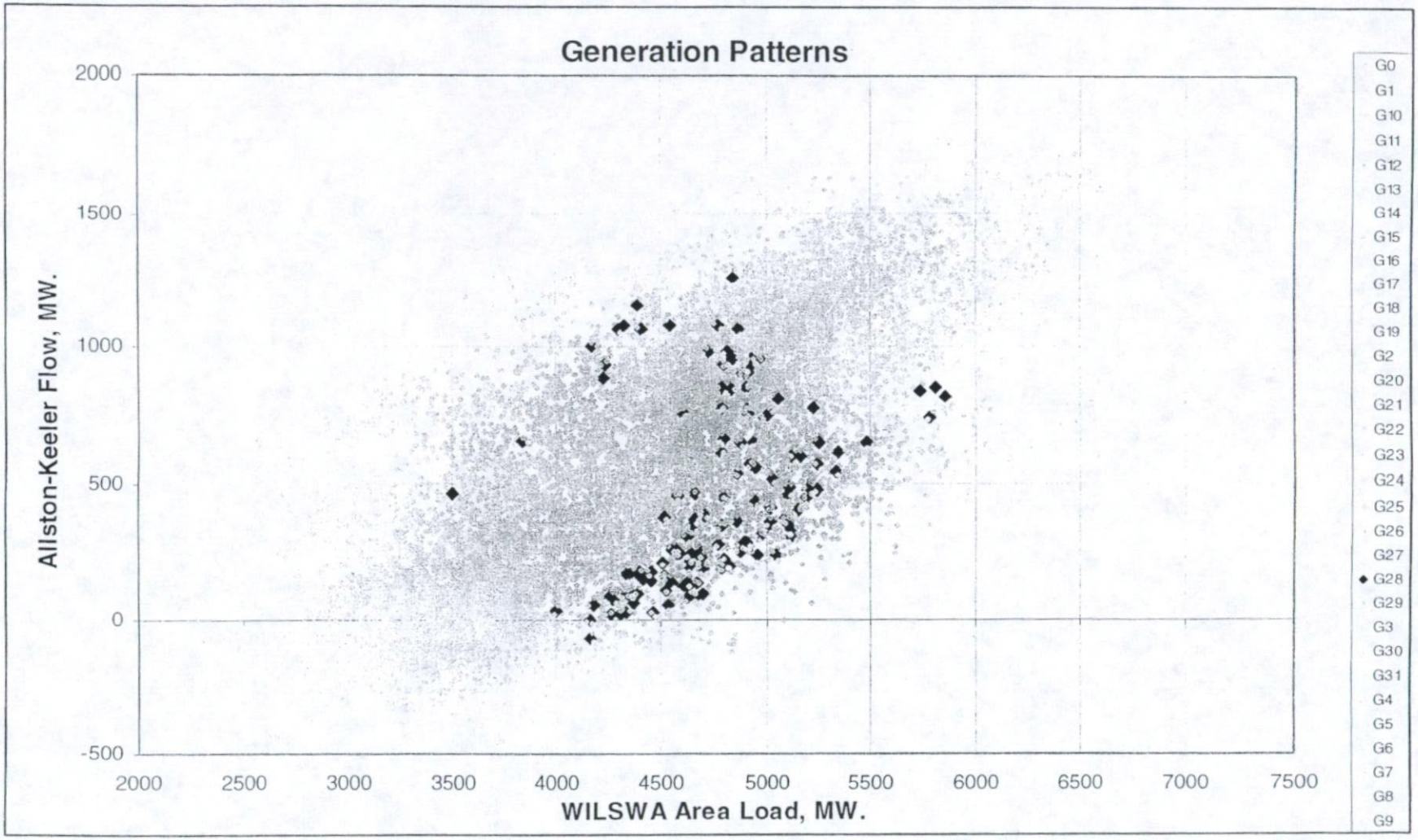

Generation Patterns
Allston-Keeler Flow, MW.
2000
1500
1000
500
0
-500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
WILSWA Area Load, MW.
G0
G1
G10
G11
G12
G13
G14
G15
G16
G17
G18
G19
G2
G20
G21
G22
G23
G24
G25
G26
G27
G28
G29
G3
G30
G31
G4
G5
G6
G7
G8
G9


Generation Patterns
Allston-Keeler Flow, MW.
2000
1500
1000
500
0
-500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
WILSWA Area Load, MW.
G0
G1
G10
G11
G12
G13
G14
G15
G16
G17
G18
G19
G2
G20
G21
G22
G23
G24
G25
G26
G27
G28
G29
G3
G30
G31
G4
G5
G6
G7
G8
G9

G24


Generation Patterns
Allston-Keeler Flow, MW.
2000
1500
1000
500
0
-500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
WILSWA Area Load, MW.
G0
G1
G10
G11
G12
G13
G14
G15
G16
G17
G18
G19
G2
G20
G21
G22
G23
G24
G25
G26
G27
G28
G29
G3
G30
G31
G4
G5
G6
G7
G8
G9


Generation Patterns
Allston-Keeler Flow, MW.
2000
1500
1000
500
0
-500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
WILSWA Area Load, MW.
G0
G1
G10
G11
G12
G13
G14
G15
G16
G17
G18
G19
G2
G20
G21
G22
G23
G24
G25
G26
G27
G28
G29
G3
G30
G31
G4
G5
G6
G7
G8
G9


Generation Patterns
Allston-Keeler Flow, MW.
2000
1500
1000
500
0
-500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
WILSWA Area Load, MW.
G0
G1
G10
G11
G12
G13
G14
G15
G16
G17
G18
G19
G2
G20
G21
G22
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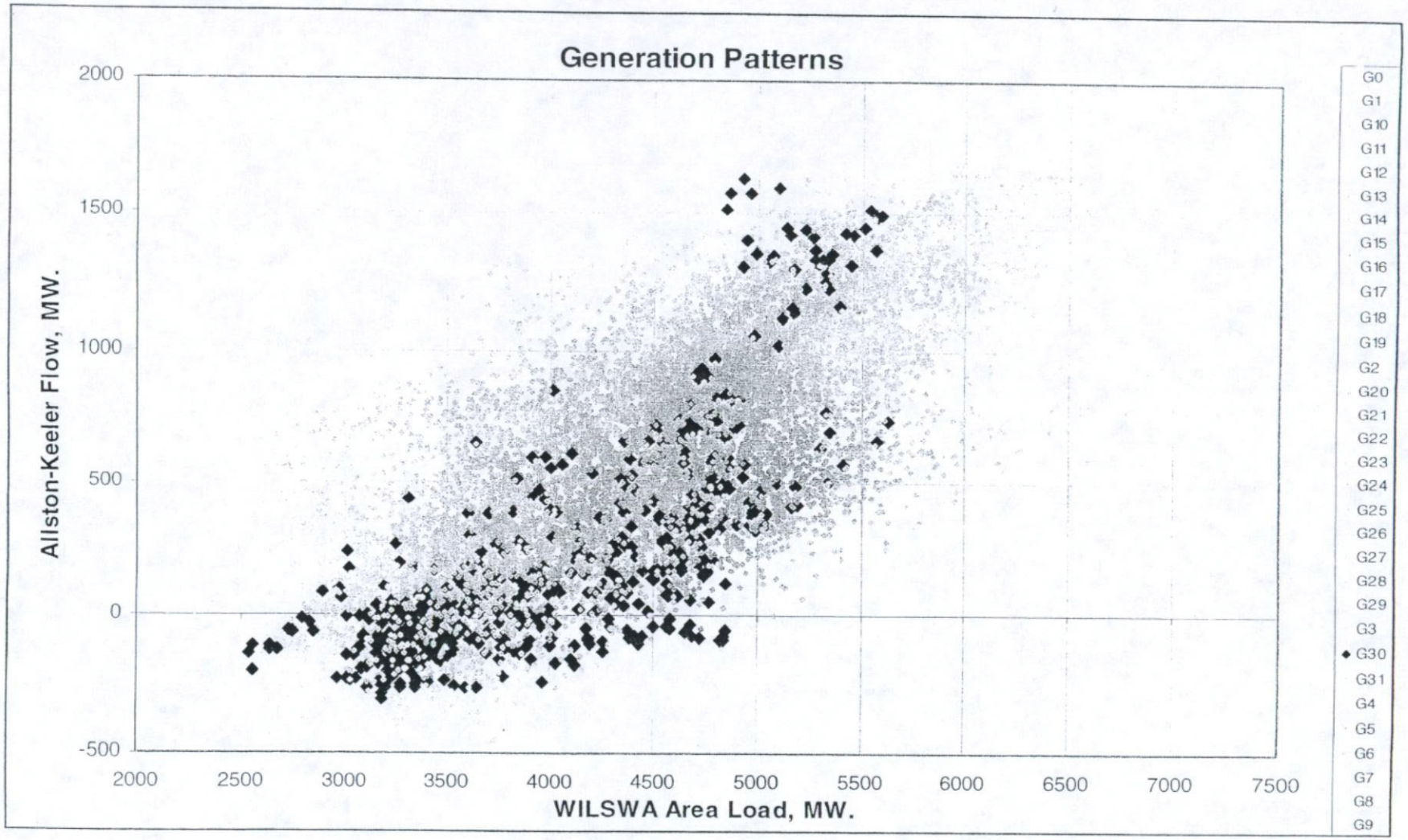
G24
G25
G26
G27
G28
G29
G3
G30
G31
G4
G5
G6
G7
G8
G9

G30


Generation Patterns
Allston-Keeler Flow, MW.
2000
1500
1000
500
0
-500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
WILSWA Area Load, MW.
G0
G1
G10
G11
G12
G13
G14
G15
G16
G17
G18
G19
G2
G20
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G23
G24
G25
G26
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G28
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G4
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G7
G8
G9

Appendix B2

Generation Pattern Tables

Table #1
I-Corridor Generators and Status

Pattern	Chehalis	Beaver	River Road	Swift	Merwin/Yale
G0	1	1	1	1	1
G1	0	1	1	1	1
G2	1	0	1	1	1
G3	0	0	1	1	1
G4	1	1	0	1	1
G5	0	1	0	1	1
G6	1	0	0	1	1
G7	0	0	0	1	1
G8	1	1	1	1	1
G9	0	1	1	1	1
G10	1	0	1	1	1
G11	0	0	1	1	1
G12	1	1	0	1	1
G13	0	1	0	1	1
G14	1	0	0	1	1
G15	0	0	0	1	1
G16	1	1	1	1	0
G17	0	1	1	1	0
G18	1	0	1	1	0
G19	0	0	1	1	0
G20	1	1	0	1	0
G21	0	1	0	1	0
G22	1	0	0	1	0
G23	0	0	0	1	0
G24	1	1	1	1	0
G25	0	1	1	1	0
G26	1	0	1	1	0
G27	0	0	1	1	0
G28	1	1	0	1	0
G29	0	1	0	1	0
G30	1	0	0	1	0
G31	0	0	0	1	0

On = 1
Off = 0

Frequency of Occurrence for Generation Patterns

WILSWA Load>=	0	4000	4000	4000	4000	4000	4000	4000	4000	4500	4500	45[illegible]
Aliston-Keeler >=	0	1000	1100	1200	1300	1400	1500	1600	1700	1000	1100	12[illegible]
G0	107	87	77	62	40	24	12	3	0	87	77	[illegible]
G1	27	22	22	14	6	0	0	0	0	22	22	[illegible]
G2	181	71	64	52	34	20	9	4	0	70	63	[illegible]
G3	69	17	8	3	1	0	0	0	0	17	8	
G4	65	4	4	3	2	0	0	0	0	4	4	
G5	97	58	47	42	32	23	14	0	0	58	47	[illegible]
G6	32	3	3	3	3	2	2	2	0	3	3	
G7	266	50	34	20	5	1	0	0	0	49	34	[illegible]
G8	78	71	65	57	48	36	21	7	1	66	61	[illegible]
G9	88	48	37	30	14	2	0	0	0	47	36	[illegible]
G10	198	57	48	34	26	17	7	0	0	55	46	[illegible]
G11	233	63	41	15	10	3	0	0	0	52	32	
G12	65	9	5	1	0	0	0	0	0	9	5	
G13	97	26	15	12	9	7	1	0	0	26	15	
G14	62	1	1	1	1	1	0	0	0	1	1	
G15	667	46	18	6	1	0	0	0	0	43	18	
G16	153	123	108	90	61	39	18	8	0	122	107	[illegible]
G17	61	49	38	20	9	5	0	0	0	49	38	[illegible]
G18	125	81	69	39	25	14	1	0	0	77	66	[illegible]
G19	142	51	38	27	6	1	0	0	0	51	38	[illegible]
G20	62	2	2	2	1	0	0	0	0	2	2	
G21	32	26	24	24	11	7	0	0	0	26	24	[illegible]
G22	24	8	7	7	6	1	0	0	0	8	7	
G23	158	42	33	14	0	0	0	0	0	42	33	
G24	512	254	179	126	67	37	18	11	1	229	166	1
G25	312	142	90	48	19	6	1	0	0	129	79	
G26	1291	246	175	128	81	39	8	0	0	221	162	1.
G27	2342	275	157	67	20	3	0	0	0	253	146	
G28	133	8	2	1	0	0	0	0	0	4	1	
G29	132	33	18	10	4	1	0	0	0	33	18	
G30	360	40	38	34	28	15	6	1	0	40	38	
G31	1842	96	49	21	2	0	0	0	0	87	47	
Total	10013	2109	1516	1013	572	304	118	36	2	1982	1444	9

WILSWA Load>=	[illegible]00	6500	6500	6500	6500	6500	6500	7000	7000	7000	7000	7000	7000	7000	7000
Aliston-Keeler >=	[illegible]00	1200	1300	1400	1500	1600	1700	1000	1100	1200	1300	1400	1500	1600	1700
G0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G5	11	11	11	9	7	0	0	2	2	2	2	2	2	0	0
G6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G8	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0
G9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G15	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
G16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G20	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
G21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G23	3	3	3	3	3	2	0	0	0	0	0	0	0	0	0
G24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G31															
Total	18	18	18	16	13	5	0	2	2	2	2	2	2	0	0

Note: Data was collected for five summer seasons and the occurrence of a speci