Generation Interconnection

Impact Study Report

for

Queue Project AE1-145

WALLOPS ISLAND 69KV

20.0 MW Capacity / 20.0 MW Energy

March 2022

Contents

1 Introduction

This System Impact Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 205, as well as the System Impact Study Agreement between the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is ODEC.

2 Preface

The intent of the System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

In some instances, an Interconnection Customer may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the Feasibility Study, but the actual allocation will be deferred until the System Impact Study is performed.

The System Impact Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

The Interconnection Customer seeking to interconnect a wind or solar generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per Schedule H to the Interconnection Service Agreement and Section 8 of Manual 14D.

An Interconnection Customer with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

3 General

The Interconnection Customer (IC) has proposed a 20 MW Energy (20 MW Capacity) hybrid solar and battery storage (AC-coupled) generating facility to be located in Wishart, Accomack County, Virginia (37.8826, -75.5120). The CIR determination is due to 60% class average CIR credit for a 20 MW ground-mounted tracking solar (12 MW) plus an 80 MWh battery storage system (10-hour PJM duration requirement per CIR = 8 additional MW CIR). The battery will be limited to an 8 MW withdrawal when charging from the grid. The planned in-service date as requested by the IC is December 1, 2020. This study does not imply an ODEC commitment to this in-service date.

Queue Number	**AE1-145**
Project Name	Wallops Solar 69kV
State	VA
County	Accomack
Transmission Owner	ODEC
MFO	20
MWE	20
MWC	20
Fuel	Solar; Storage
Base Case Study Year	2022

Any new service customers who can feasibly be commercially operable prior to June 1st of the basecase study year are required to request interim deliverability analysis.

4 Point of Interconnection

The IC requested a transmission level interconnection. AE1-145 will interconnect with the ODEC system adjacent to the Wallops Island 69kV substation, on land to be acquired by the IC.

5 Cost Summary

The AE1-145 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	$7,891,000 to $10,812,000
Allocation towards System Network Upgrade Costs (PJM Identified - Summer Peak)*	$0
Allocation towards System Network Upgrade Costs (PJM Identified - Light Load)*	$0
Allocation towards System Network Upgrade Costs (TO Identified)*	$5,500,000
Total Costs	$13,391,000 to $16,312,000

*As your project progresses through the study process and other projects modify their request or withdraw, then your cost allocation could change.

This cost excludes a Federal Income Tax Gross Up charges. This tax may or may not be charged based on whether this project meets the eligibility requirements of IRS Notice 88-129. If at a future date it is determined that the Federal Income Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Interconnection Customer for such taxes.

Note 1: PJM Open Access Transmission Tariff (OATT) section 217.3A outline cost allocation rules. The rules are further clarified in PJM Manual 14A Attachment B. The allocation of costs for a network upgrade will start with the first Queue project to cause the need for the upgrade. Later queue projects will receive cost allocation contingent on their contribution to the violation and are allocated to the queues that have not closed less than 5 years following the execution of the first Interconnection Service Agreement which identifies the need for this upgrade.

Note 2: For customers with System Reinforcements listed: If your present cost allocation to a System Reinforcement indicates $0, then please be aware that as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue,

reducing in size, etc, the cost responsibilities can change and a cost allocation may be assigned to your project. In addition, although your present cost allocation to a System Reinforcement is presently $0, your project may need this system reinforcement completed to be deliverable to the PJM system. If your project comes into service prior to completion of the system reinforcement, an interim deliverability study for your project will be required.

6 Transmission Owner Scope of Work

6.1 Attachment Facilities

The IC requested the POI for AE1-145 to be at the Wallops Island 69kV substation. Given the local reliability issues associated with serving load at the Chincoteague 69kV substation, the AE1-145 project will have to be interconnected on the Wattsville - Wallops Island Line using a 69kV 3-breaker ring-bus substation. With no other interconnection customers in the immediate vicinity of AE1-145, the entire cost of the 69kV 3-breaker ring-bus substation, a new 69kV 5-breaker ring bus switching station at the Wallops Island tap and new equipment at Wattsville in this report will be allocated to the AE1-145 project.

Description	Total Cost
Provide a 69kV terminal at the new 3- breaker ring bus station to connect the AE1-145 project.	$242,000
Total Attachment Facility Costs	$242,000

6.2 Direct Connection Cost Estimate

Build a new 69kV substation with a 3-breaker ring bus. One of the positions on the ring bus will be the Wallops Island terminal for the Wattsville - Wallops Island 69kV line (Line 6748). Another position will be used for existing Transformer No. T1 at Wallops Island substation. A third position will be a terminal configured for the hybrid solar and battery storage facility with a disconnect switch. The POI will be at the terminal frame of the disconnect switch on the IC side. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
The major equipment for the substation will include circuit breakers, disconnect switches, protective relays, foundations, control building, control wiring, security lighting and fence. GSU provided by the customer is to be connected delta on the generator side and wye-grounded on the POI side. Lead time is estimated to be 24 months	$5,000,000

Total Direct Connection Facility Costs	$5,000,000

6.3 Non-Direct Connection Cost Estimate

Network Upgrades and Anti-Islanding Detection Requirements

In accordance with PJM requirements as specified in Manual 14A, unintentional islanding or anti-islanding requirements can be met with transfer trip. Given the configuration of the transmission system in the ODEC area, anti-islanding will be required for line terminals at Wattsville substation and all possible open points between Wattsville and the POI. A dedicated fiber network is required for the anti-islanding detection scheme to work properly.

Scope

1. Replace the ground wire with OPGW over the 69kV transmission lines between Wattsville, the Wallops Island tap and Wallops Island substation (Line 6748). A detailed engineering study will be required during the facilities study phase to determine the number of transmission structures requiring replacement to carry the OPGW. The cost of this study is estimated at $65,000.

2. Delmarva Power & Light (DPL) as an affected entity will need to install Transfer Trip scheme for anti-islanding purposes and may also need to install upgraded line and breaker relaying at Wattsville substation. This scope will be finalized and estimated during the facilities studies phase working along with DPL.

Description	Total Cost
New communications equipment at Wattsville: Auxiliary Switches on all 69kV switches One SEL-3530 islanding detection controller One SEL-421 relay Replacement of ground wire with OPGW on Lines 6745 and 6748 between Wattsville, Wallops Island tap and Wallops Island substation.	$2,149,000 (if 10% of the structures need replacement) $5,070,000 (if 80% of the structures need replacement) $500,000 (remote terminal work)
Total Non-Direct Connection Facility Costs	$2,649,000 to $5,570,000

Assumptions

ODEC will begin the project only after the PJM ISA and ICSA are fully executed and ODEC receives a written authorization by PJM to commence activities. The estimated time to complete the direct connection work is approximately 24 months after the execution of an ICSA. The schedule for the 69kV transmission and substation work to accommodate the AE1-145 project would depend on the project start date. The work to accommodate the AE1-145 project will require transmission line outages. ODEC's outage windows for construction are typically in the spring and fall of the year; missing an outage window could result in project delays.

Excepting any operational, governmental and/or environmental regulatory delays, the use of additional resources, such as overtime, premiums for expedited material, and/or contractor labor, may enable ODEC to decrease this construction period. It is also assumed that all right-of-way and easements are secured without impact on anticipated construction start dates.

The System Impact Study results included in this report only cover a portion of the System Impact Study results. The results in this report do not include the additional studies required by ODEC to determine all impacts on ODEC's 69kV system. These studies include:

- Harmonic Study
- Steady State Analysis of Island Combinations
- Temporary Overvoltage Analysis.

ODEC cannot perform the studies needed to determine those impacts, or estimate the costs of related network upgrades, until after the Interconnection Customer provides ODEC with the data required to perform the studies. This data was requested in the Feasibility Study and has not been received. If the Interconnection Customer chooses to proceed with the project, it shall pay all costs of those additional studies and provide the required data during the Facilities Study phase. The studies will need to be reperformed, at the Interconnection Customer's cost, if the Interconnection customer changes the data submitted as a result of changes to the equipment selection or any Material Modifications to this project.

Interconnection Construction Service Agreements (ICSA), Interconnection Service Agreements (ISA) and or Wholesale Market Participant Agreements (WMPA) will not be issued until the studies from ODEC have been completed and decisions on how to mitigate issues detailed by these studies have been determined.

7 Schedule

Based on the scope of work for the interconnection facilities, it is expected to take a minimum of 24 months after the signing of an Interconnection Agreement and construction kickoff call to complete the installation of the physical connection work. This assumes that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined interconnection work, and that all system outages will be allowed when requested.

The schedule for any required Network Impact Reinforcements will be more clearly identified in future study phases. The estimated time to complete each of the required reinforcements is identified in the "System Reinforcements" section of the report.

8 Transmission Owner Analysis

The following contingencies resulted in overload during peak analysis, with the loss of Wattsville to Wallops Tap (6745):

Branch									
From Number	From Name	kV	To Number	To Name	kV	Circuit	Limiting Flow Used	Limit Used	% of Limit Used
232281	WATTSVIL	69	232282	CHINCOTG	69	1	36.1	35	103.2

To resolve the N-1 contingencies above:

1. Build a new 5-breaker 69kV ring bus substation at the site of the Wallops Tap. Two of the positions on the ring bus will be used for each of the 69kV lines from Wattsville Substation. Two other positions will be used for each of the 69kV lines to Chincoteague Substation. A fifth position will be used for the former 6748 line to Wallops Substation, which will become the line from Wallops Tap to the 3-breaker 69kV ring bus substation.

Description	Total Cost
The major equipment for the substation will include circuit breakers, disconnect switches, protective relays, foundations, control building, control wiring, security lighting and fence. Note: This estimate does NOT include the costs of obtaining permits, additional rights-of-way, easements or property.	$5,500,000

9 Interconnection Customer Requirements

1. The IC is responsible for all design and construction related to activities on its side of the POI as shown on Attachment 1. Site preparation, including grading and an access road as

necessary, is assumed to be by the IC. Route selection, line design, and right-of-way acquisition of the Direct-Connect facilities is not included in this report and is the responsibility of the IC. The Direct-Connect 69kV line from the IC's facilities to the interconnection substation must be built in accordance with Rural Utilities Service (RUS) standards or an acceptable national standard, effectively grounded, and appropriately shielded from lightning (refer to RUS Bulletins 1728f-810 and 1724E-200). The IC's transformer shall be connected wye-ground on the 69kV side and delta on the low-voltage side. The IC is also required to provide revenue metering and real-time telemetering data to PJM in conformance with the requirements contained in PJM Manuals M-01 and M-14 and the PJM Tariff.

2. Installation of revenue grade Metering Equipment will be required at the POI. ODEC will install power quality metering to monitor compliance with industry standards for harmonics and other power quality requirements. The IC is also required to provide revenue metering and real-time telemetry data to PJM in compliance with the requirements listed in PJM Manuals M-01 and M-14. At the IC's discretion, ODEC will design and supply the required telemetering equipment but all the installation cost and on-going costs will be borne by the IC. If the IC chooses to provide the metering, the IC will provide ODEC read only access to its PJM metering account for this site for verification of billing for ODEC.

10 Revenue Metering and SCADA Requirements

10.1 PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M- 14D, and PJM Tariff Section 8 of Attachment O.

10.2 Meteorological Data Reporting Requirements

The solar generation facility shall provide the Transmission Provider with site-specific meteorological data including:

- Temperature (degrees Fahrenheit)
- Atmospheric pressure (hectopascals)
- Irradiance
- Forced outage data

10.3 ODEC Requirements

The Interconnection Customer will be required to comply with all ODEC Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "Technical Requirements For Generation Connected to The ODEC System" document located at the following link:

https://www.pjm.com/planning/design-engineering/to-tech-standards/private-odec.aspx

11 Summer Peak Analysis – 2022

The Queue Project AE1-145 was evaluated as a 20.0 MW (Capacity 20.0 MW) injection tapping directly into the Wallops Island 69kV substation in the ODEC area. Project AE1-145 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE1-145 was studied with a commercial probability of 100%. Potential network impacts were as follows:

11.1 Generation Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection):

None

11.2 Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output):

None

11.3 Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue):

1. (DP&L - DP&L) The TODD-PRESTON 69 kV line (from bus 232234 to bus 232233 ckt 1) loads from 111.61% to 113.6% (AC power flow) of its emergency rating (93 MVA) for the line fault with failed breaker contingency outage of 'DPL_P4-2_DP11'. This project contributes approximately 2.21 MW to the thermal violation.

CONTINGENCY 'DPL_P4-2_DP11' /*STEELE BUS BREAKER TO MILFORD

DISCONNECT BRANCH FROM BUS 232004 TO BUS 232000 CKT 1 /*MILFORD STEELE 230 230

DISCONNECT BRANCH FROM BUS 232000 TO BUS 232005 CKT 1 /*STEELE VIENNA 230 230

END

Please refer to Appendix 1 for a table containing the generators having contribution to this flowgate.

11.4 Potential Congestion due to Local Energy Deliverability

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified:

None

12 Light Load Analysis – 2022

The Queue Project AE1-145 was evaluated as a 20.0 MW (Capacity 8.0 MW) injection and 8.0 MW withdrawal tapping directly into the Wallops Island 69kV substation in the ODEC area. Project AE1-145 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE1-145 was studied with a commercial probability of 100%. Potential network impacts were as follows:

12.1 Generation Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection):

None

12.2 Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output):

None

12.3 Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue):

None

13 System Reinforcements

Facility	Upgrade Description	Cost	Cost Allocation
Todd 69 kV – Preston 69 kV Ckt. 1	**Project ID**: n5788 **Description**: To mitigate the (DP&L) TODD to PRESTON 69 kV line (from bus 232234 to bus 232233 Ckt. 1) overload will require substation reinforcements at Todd Substation. Replace 600A Disconnect Switch at Todd. **Type**: FAC **Time Estimate**:12 Months **Ratings**: 95/130/130 **Notes**: Per PJM cost allocation rules, this project presently does not receive cost allocation for this upgrade. This may change as projects ahead withdraws from the Queue.	$100,000	$0
	Total Cost	$100,000	$0

14 Short Circuit

The following circuit breakers are over-dutied:

None

15 Steady-State Voltage Requirements

(Summary of the VAR requirements based upon the results of the steady-state voltage studies):

To be determined during the Facilities Study Phase.

16 Stability and Reactive Power Requirement for Low Voltage Ride Through

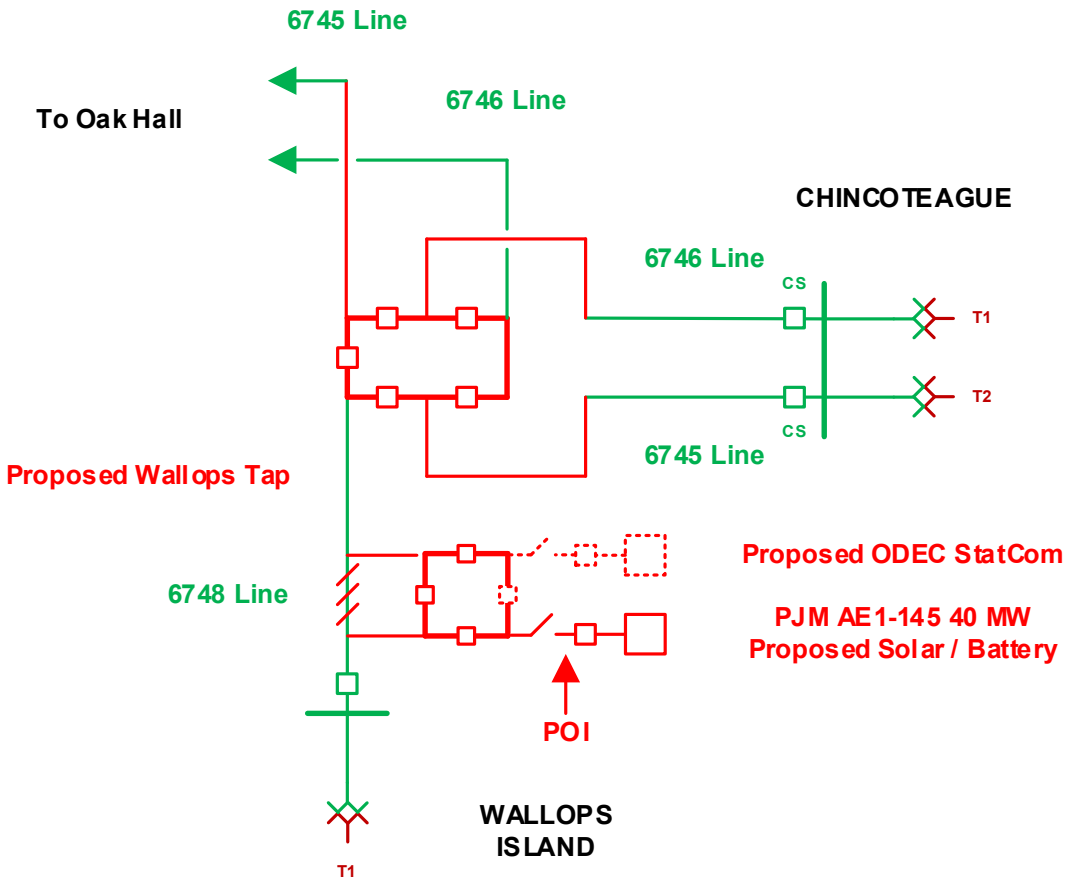
(Summary of the VAR requirements based upon the results of the dynamic studies):

To be determined during the Facilities Study Phase.

17 Affected Systems

None

18 Attachment 1. Single Line Diagram



19 Appendices

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the Appendices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the Appendices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators.

It should be noted the project/generator MW contributions presented in the body of the report and appendices sections are full contributions, whereas the loading percentages reported in the body of the report, take into consideration the commercial probability of each project as well as the ramping impact of "Adder" contributions.

19.1 Appendix 1

(DP&L - DP&L) The TODD-PRESTON 69 kV line (from bus 232234 to bus 232233 ckt 1) loads from 111.61% to 113.6% (AC power flow) of its emergency rating (93 MVA) for the line fault with failed breaker contingency outage of 'DPL_P4-2_DP11'. This project contributes approximately 2.21 MW to the thermal violation.

```
CONTINGENCY 'DPL_P4-2_DP11'                          /*STEELE BUS BREAKER TO MILFORD
 DISCONNECT BRANCH FROM BUS 232004 TO BUS 232000 CKT 1        /*MILFORD STEELE 230
230
 DISCONNECT BRANCH FROM BUS 232000 TO BUS 232005 CKT 1        /*STEELE VIENNA 230
230
 END
```

Bus Number	*Bus Name*	*Full Contribution*
932161	*AC2-023 C*	*4.39*
932162	*AC2-023 E*	*3.2*
938651	*AE1-087 C*	*6.12*
938652	*AE1-087 E*	*1.53*
938891	*AE1-117 C O1*	*3.3*
938892	*AE1-117 E O1*	*8.78*
939151	*AE1-145 C1*	*2.21*
232905	*BAYVIEW1*	*0.2*
LTF	*BLUEG*	*0.38*
LTF	*CALDERWOOD*	*0.04*
LTF	*CANNELTON*	*0.02*
LTF	*CARR*	*0.02*
LTF	*CATAWBA*	*0.03*
LTF	*CHEOAH*	*0.04*
LTF	*CHILHOWEE*	*0.01*
LTF	*COFFEEN*	*0.04*
LTF	*COTTONWOOD*	*0.16*
232926	*CRISFLD1*	*0.17*
LTF	*DUCKCREEK*	*0.09*
LTF	*EDWARDS*	*0.04*
LTF	*FARMERCITY*	*0.03*
LTF	*G-007*	*0.05*
LTF	*GIBSON*	*0.02*
LTF	*HAMLET*	*0.04*
LTF	*NEWTON*	*0.11*
293670	*O-025 C*	*0.11*
LTF	*O-066*	*0.34*
232912	*OH NUG1*	*0.5*
232914	*OH NUG3*	*0.5*
232915	*OH NUG4*	*0.5*
232916	*OH NUG5*	*0.5*
LTF	*PRAIRIE*	*0.2*
LTF	*RENSSELAER*	*0.02*
LTF	*SANTEETLA*	*0.01*

LTF	*SMITHLAND*	*0.02*
232921	*TASLEY2G*	*0.34*
LTF	*TATANKA*	*0.05*
LTF	*TILTON*	*0.05*
LTF	*TRIMBLE*	*0.04*
LTF	*TVA*	*0.13*
LTF	*UNIONPOWER*	*0.06*
232919	*VN10*	*0.31*
232907	*VN8*	*3.26*
901003	*W1-003 C*	*0.25*
901004	*W1-003 E*	*0.5*
901013	*W1-004 C*	*0.25*
901014	*W1-004 E*	*0.5*
901023	*W1-005 C*	*0.25*
901024	*W1-005 E*	*0.5*
901033	*W1-006 C*	*0.25*
901034	*W1-006 E*	*0.5*
907052	*X1-032 E*	*0.46*
910571	*X3-008 C*	*0.42*
910572	*X3-008 E*	*4.75*
913411	*Y1-080 C*	*0.05*
913412	*Y1-080 E*	*0.57*
915541	*Y3-058 C*	*0.13*
915542	*Y3-058 E*	*1.41*
917081	*Z2-012 C*	*0.12*
917082	*Z2-012 E*	*1.37*
917432	*Z2-076 E*	*0.18*
917442	*Z2-077 E*	*0.18*
918831	*AA1-102 C*	*0.99*
918832	*AA1-102 E*	*10.93*
930202	*AB1-056 E O1*	*13.54*
924831	*AB2-136 C*	*7.74*
924832	*AB2-136 E*	*8.21*
925151	*AB2-172 C*	*7.27*
925152	*AB2-172 E*	*11.86*
925261	*AB2-180 C*	*2.12*
925262	*AB2-180 E*	*0.91*
927031	*AC1-190 C*	*12.81*
927032	*AC1-190 E*	*5.49*
927191	*AC1-213 C*	*0.42*
927192	*AC1-213 E*	*0.27*