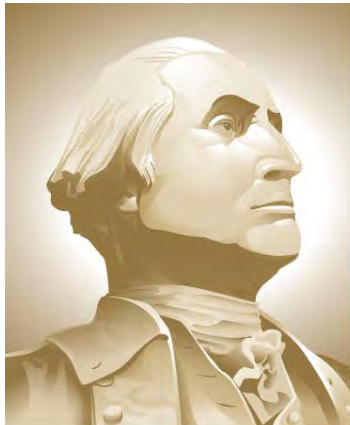


VTRA 2010 CASE T RESULTS BY ACCIDENT TYPE

Presentation by: J. Rene van Dorp



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V
C
U

CASE T: Gateway, Kinder Morgan, Delta Port

GWU Personnel: Dr. J. Rene van Dorp

VCU Personnel: Dr. Jason R. W. Merrick

OCTOBER 9, 2013

PRELIMINARY

Table. Focus Vessel (FV) Classification for the 26 VTOSS vessel type classification used in the GW/VCU MTS simulation model.

- NON – FV** : Those vessels that Interacting Vessels (IV) with Focus Vessels (FV)
- BASE CASE CARGO – FV** : Bulk Carriers, Container Vessels, Other Cargo Vessels that travel in VTRA 2010 Base Case
- BASE CASE TANK – FV** : Oil Barge, Oil Tankers, Chemical Carrier, ATB 's that travel in VTRA 2010 Base Case
- WHAT IF – FV** : CARGO AND TANK FV'S added to VTRA 2010 Base Case to model What-If Scenario

Note: Focus Vessels (FV's) are also considered as Interacting Vessels (IV's) when interacting with another Focus Vessel.

#	VESSEL TYPE	FOCUS VESSEL?	#	VESSEL TYPE	FOCUS VESSEL?
1	BULKCARRIER	CARGO - FV	14	PASSENGERSHIP	NO
2	CHEMICALCARRIER	TANK - FV	15	REFRIGERATEDCARGO	CARGO-FV
3	CONTAINERSHIP	CARGO - FV	16	RESEARCHSHIP	NO
4	DECKSHIPCARGO	CARGO - FV	17	ROROCARGOSHIP	CARGO-FV
5	FERRY	NO	18	ROROCARGOCONTSHIP	CARGO-FV
6	FERRYNONLOCAL	NO	19	SUPPLYOFFSHORE	NO
7	FISHINGFACTORY	NO	20	TUGTOWBARGE	NO
8	FISHINGVESSEL	NO	21	UNKNOWN	NO
9	LIQGASCARRIER	TANK - FV	22	USCOASTGUARD	NO
10	NAVYVESSEL	NO	23	VEHICLECARRIER	CARGO-FV
11	OILTANKER	TANK - FV	24	YACHT	NO
12	OTHERSPECIALCARGO	CARGO - FV	25	ATB	TANK - FV
13	OTHERSPECIFCSERV	NO	26	OIL BARGE	TANK - FV

IMPORTANT:

THE OPERATIVE WORD IN PRESENTING THESE ANALYSIS RESULTS IS THE USE OF THE WORD

POTENTIAL

TO INDICATE THAT THESE ANALYSIS RESULTS DO NOT FOLLOW FROM AN HISTORICAL DATA ANALYSIS, BUT THROUGH THE USE OF AN ANALYSIS TOOL THAT EVALUATES SUCH **POTENTIAL**.

THE 2010 YEAR IS CONSIDERED **THE BASE CASE YEAR** AND A BASE CASE YEAR POTENTIAL IS EVALUATED.

NEXT, **WHAT-IF SCENARIOS** ARE DEVELOPED FROM THE BASE CASE BY ADDING ADDITIONAL HYPOTHETICAL TRAFFIC AND A WHAT-IF POTENTIAL IS EVALUATED AND COMPARED **RELATIVE TO THE BASE CASE** TO INFORM **RISK MANAGEMENT**.

CASE T: GW 487, KM 348, DP 348 and 67:

**BASE CASE 2010 TRAFFIC WITH
FOLLOWING WHAT-IF FOCUS VESSELS**

487 Gateway Bulk Carriers + Bunkering Barges

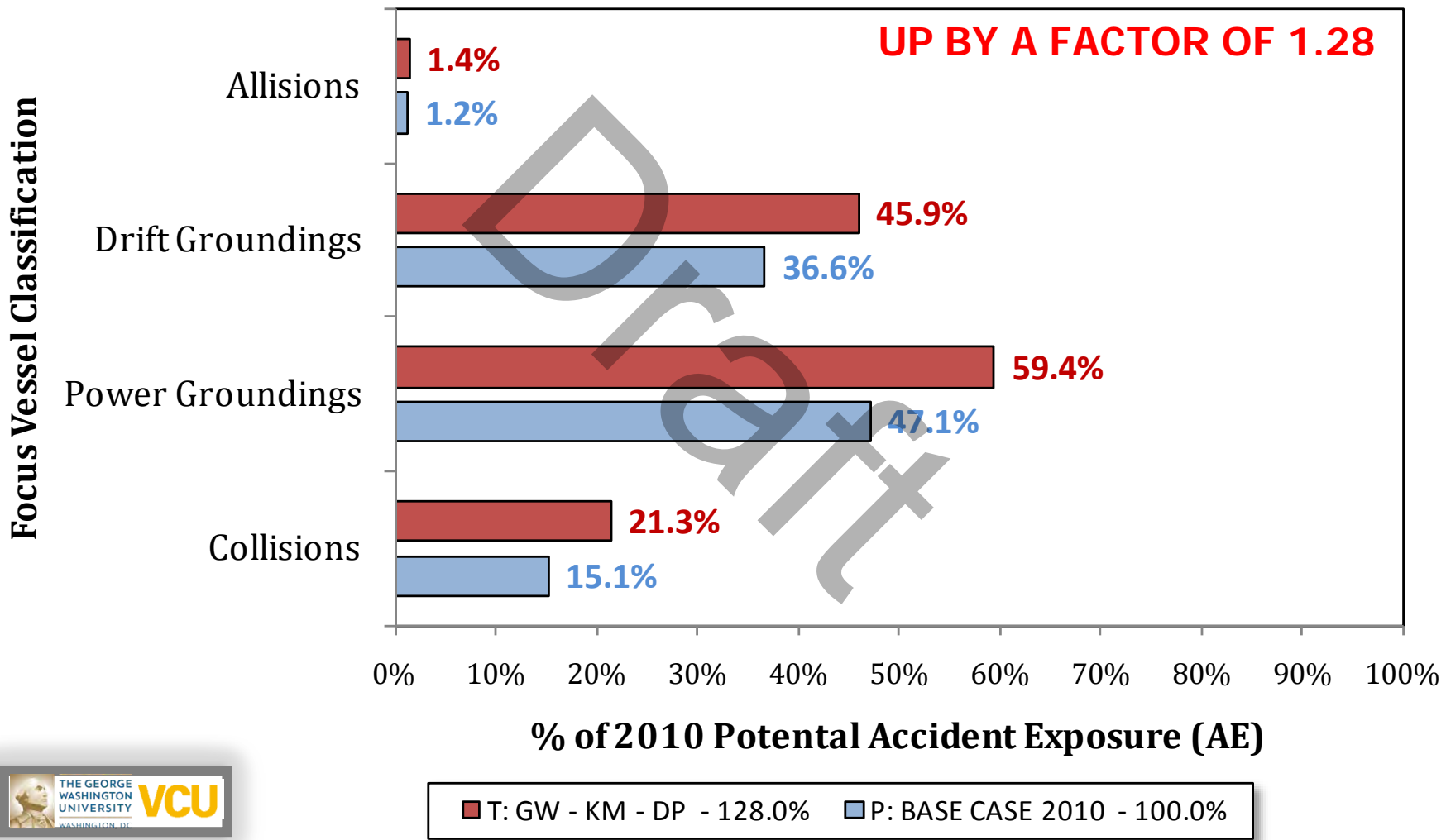
348 Kinder Morgan Tankers + Bunkering Barges

348 Delta Port Bulk Carriers + Bunkering Barges

67 Delta Port Container Ships+ Bunkering Barges

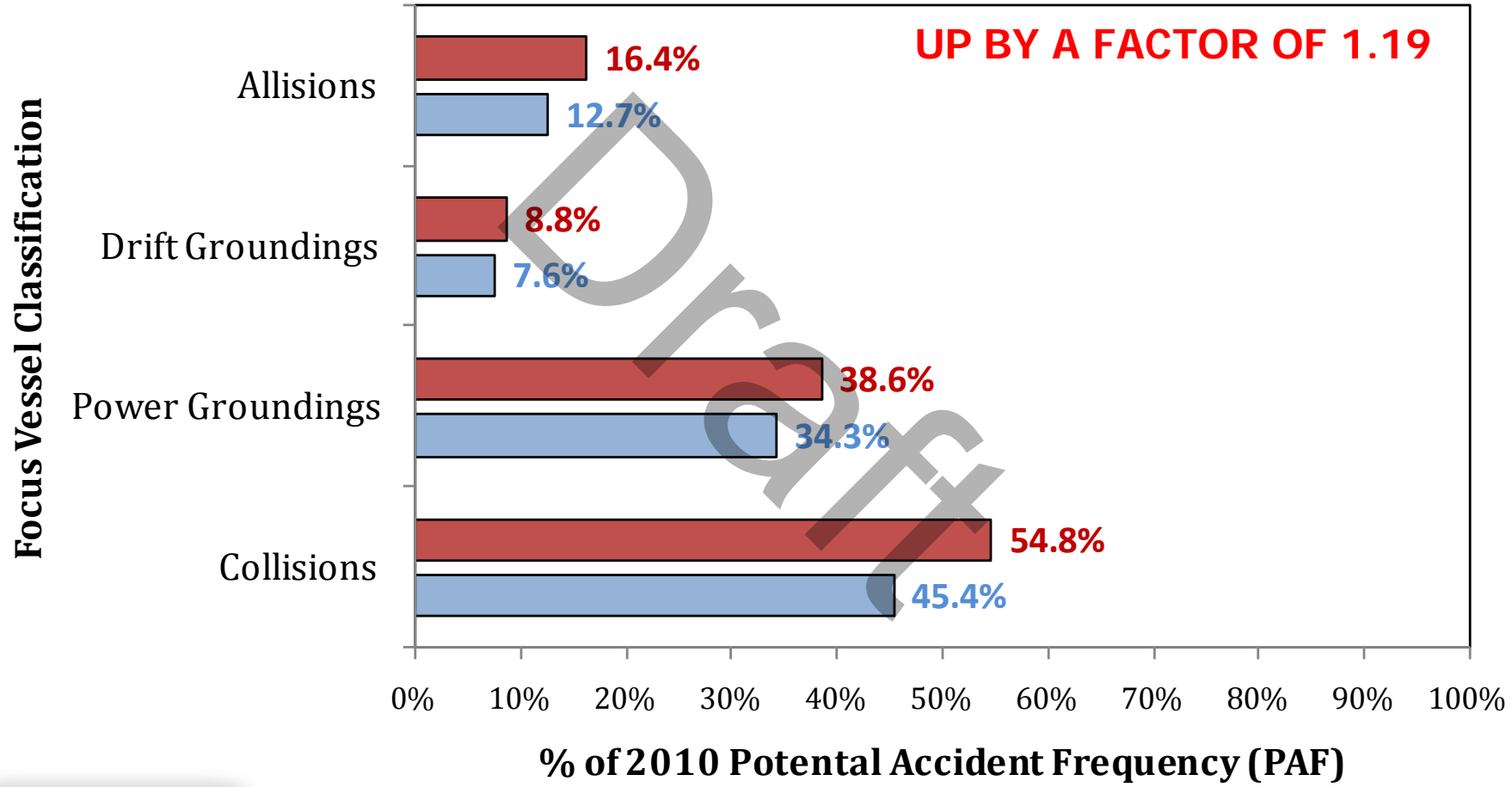
CASE T: GW 487, KM 348, DP 348 and 67:

VTRA 2010 - ACCIDENT EXPOSURE



CASE T: GW 487, KM 348, DP 348 and 67:

VTRA 2010 - ACCIDENT FREQUENCY

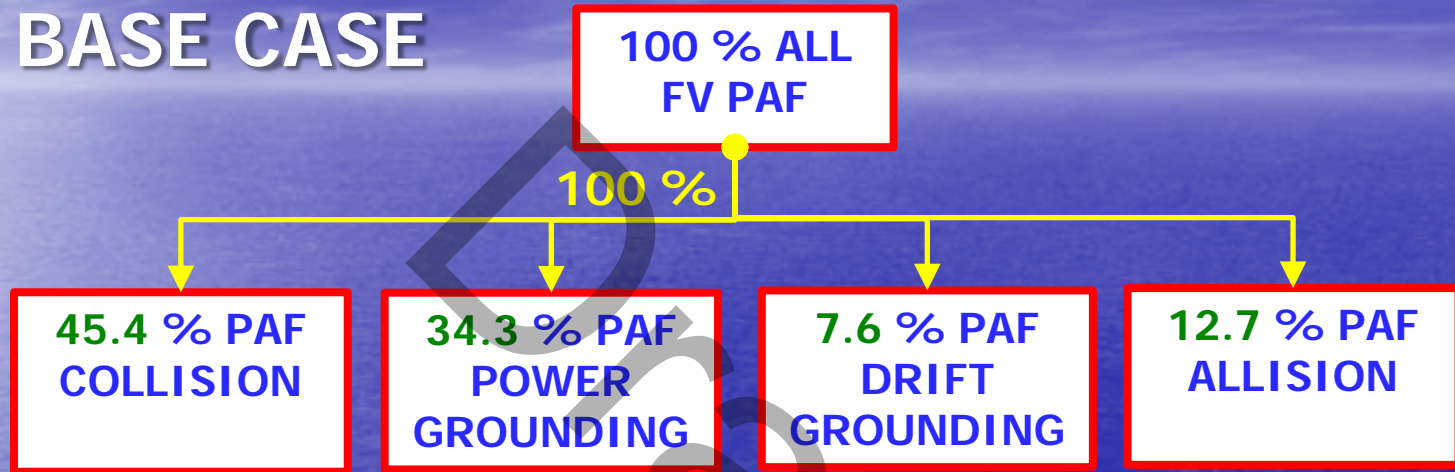


■ T: GW - KM - DP - 118.5% ■ P: BASE CASE 2010 - 100.0%

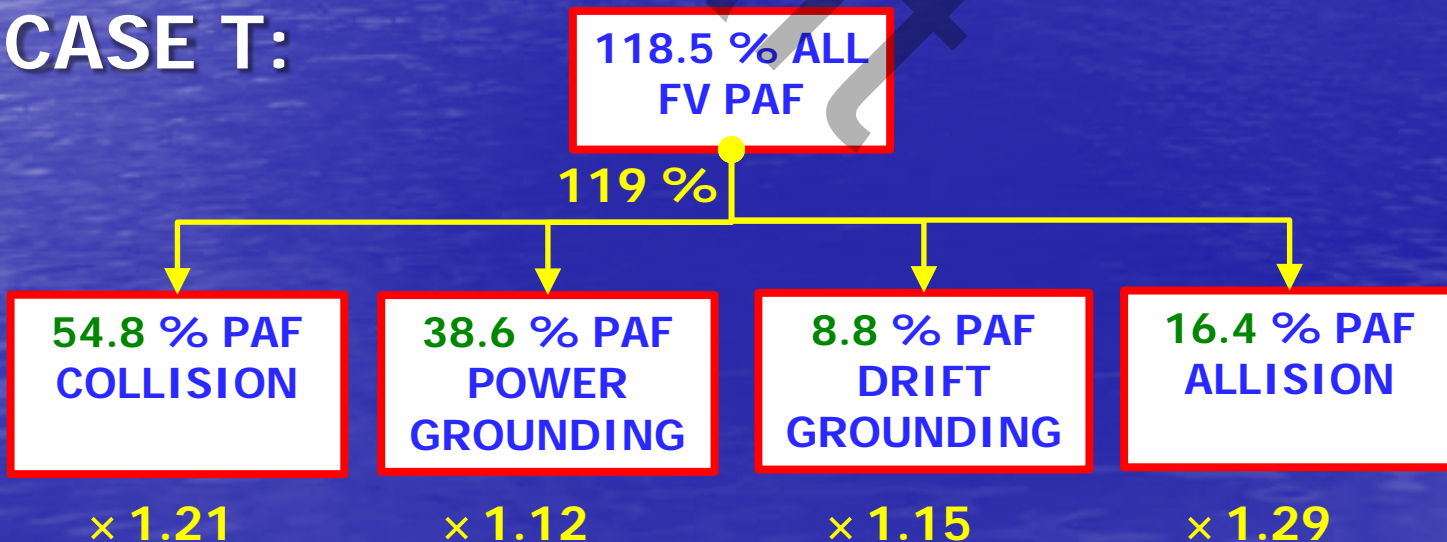
A TAXONOMY OF 2010 FOCUS VESSEL POTENTIAL ANNUAL ACCIDENT FREQUENCY

PAF : POTENTIAL ACCIDENT FREQUENCY - PER YEAR

2010 BASE CASE

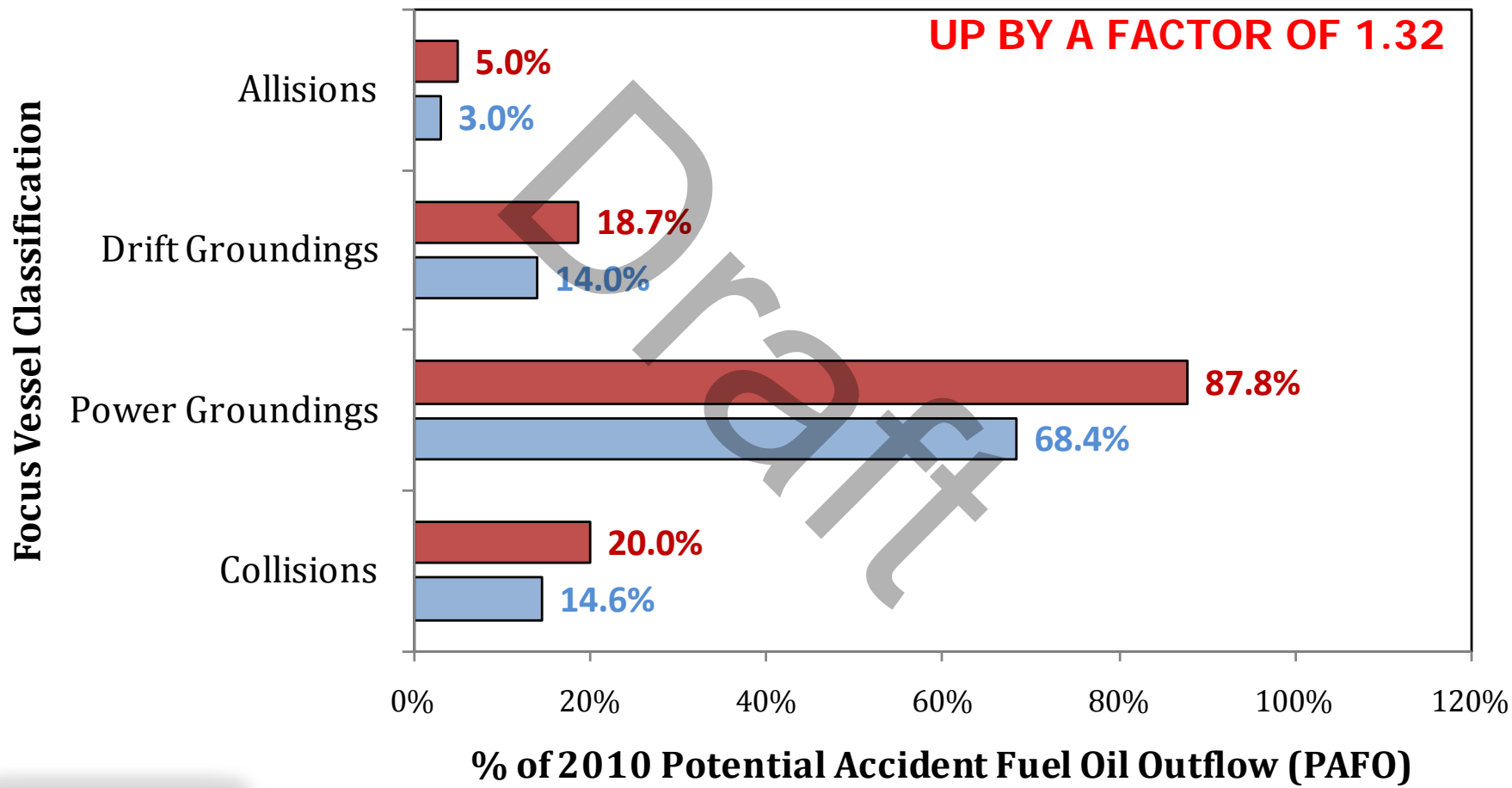


2010 CASE T:



CASE T: GW 487, KM 348, DP 348 and 67:

VTRA 2010 - ACCIDENT FUEL OIL LOSS

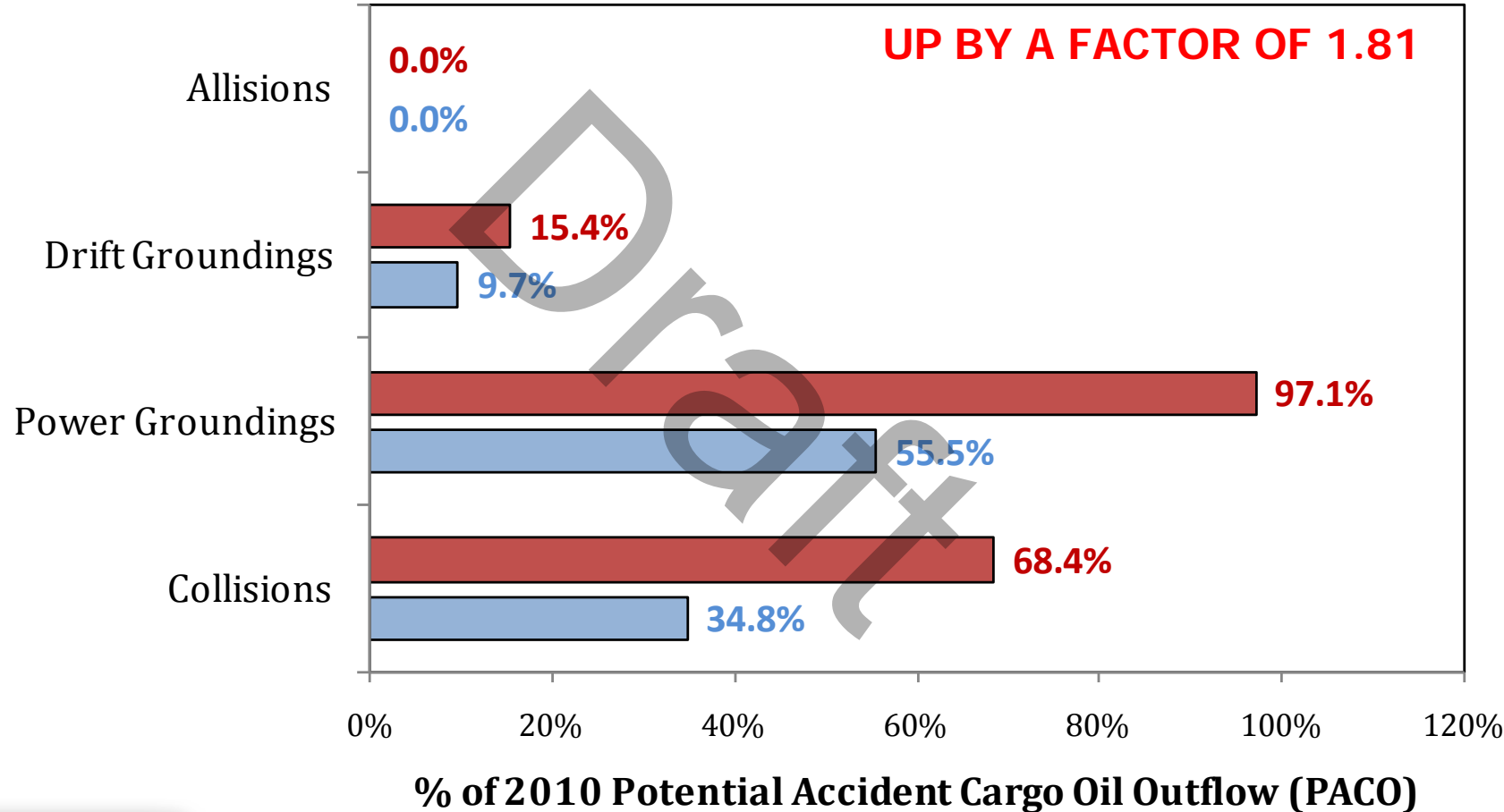


■ T: GW - KM - DP - 131.5% ■ P: BASE CASE 2010 - 100.0%

CASE T: GW 487, KM 348, DP 348 and 67:

VTRA 2010 - ACCIDENT CARGO OIL LOSS

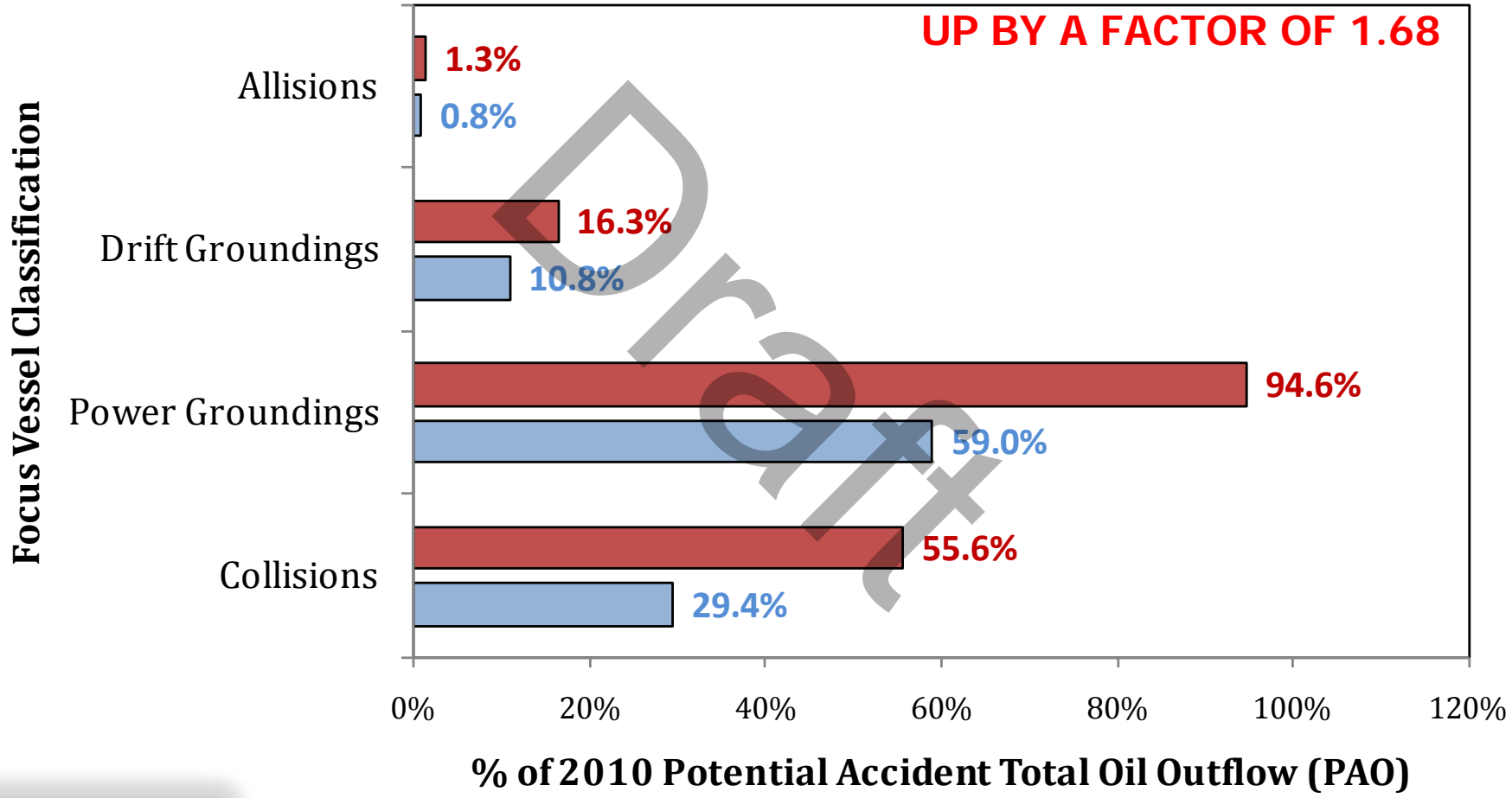
Focus Vessel Classification



■ T: GW - KM - DP - 181.0% ■ P: BASE CASE 2010 - 100.0%

CASE T: GW 487, KM 348, DP 348 and 67:

VTRA 2010 - ACCIDENT OIL LOSS (CARGO + FUEL)

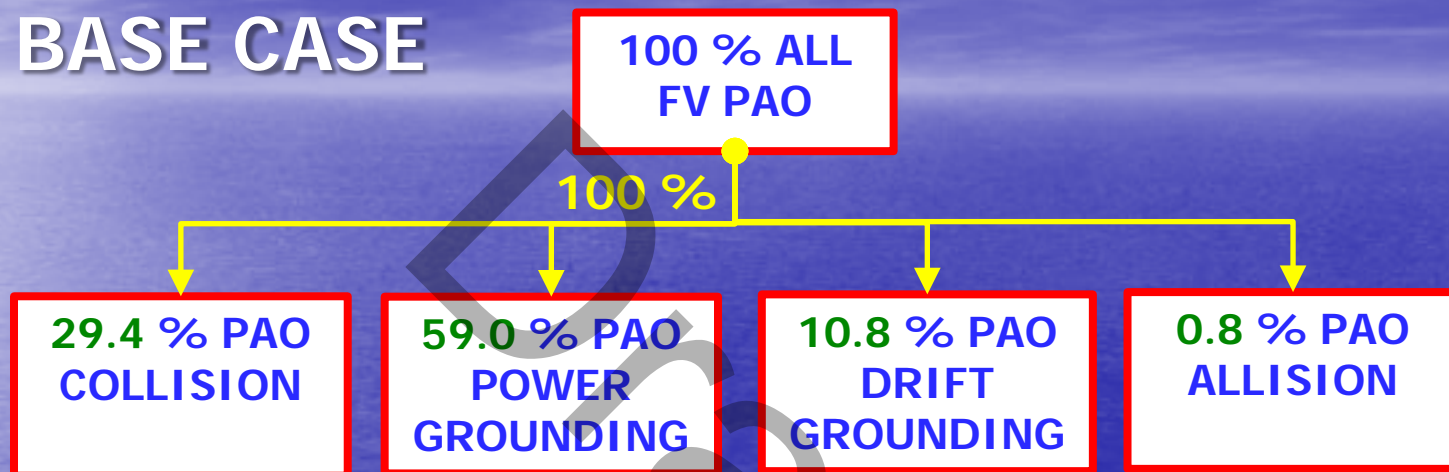


■ T: GW - KM - DP - 167.8% ■ P: BASE CASE 2010 - 100.0%

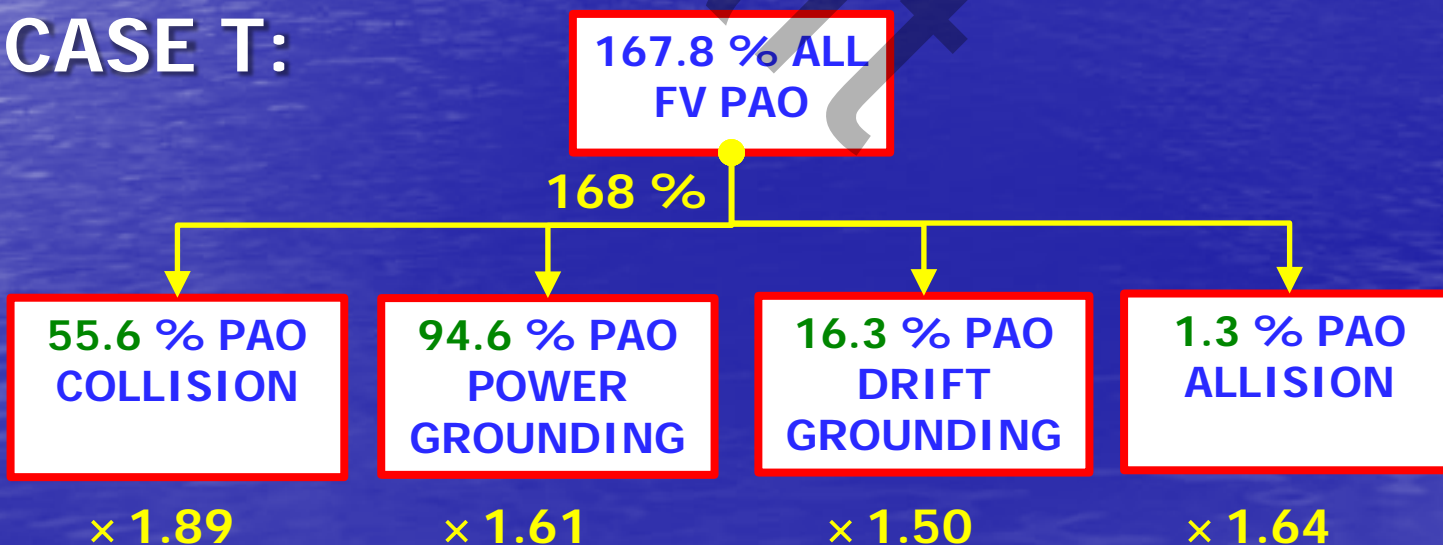
A TAXONOMY OF 2010 FOCUS VESSEL POTENTIAL ANNUAL ACCIDENT OIL (CARGO + FUEL) LOSS

PAF : POTENTIAL ACCIDENT OIL LOSS - PER YEAR

2010 BASE CASE

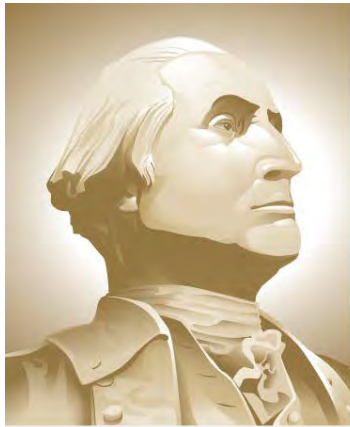


2010 CASE T:



VTRA 2010 CASE T RESULTS – COLLISION EXPOSURE AND ACCIDENT GEOGRAPHIC PROFILES

Presentation by: J. Rene van Dorp



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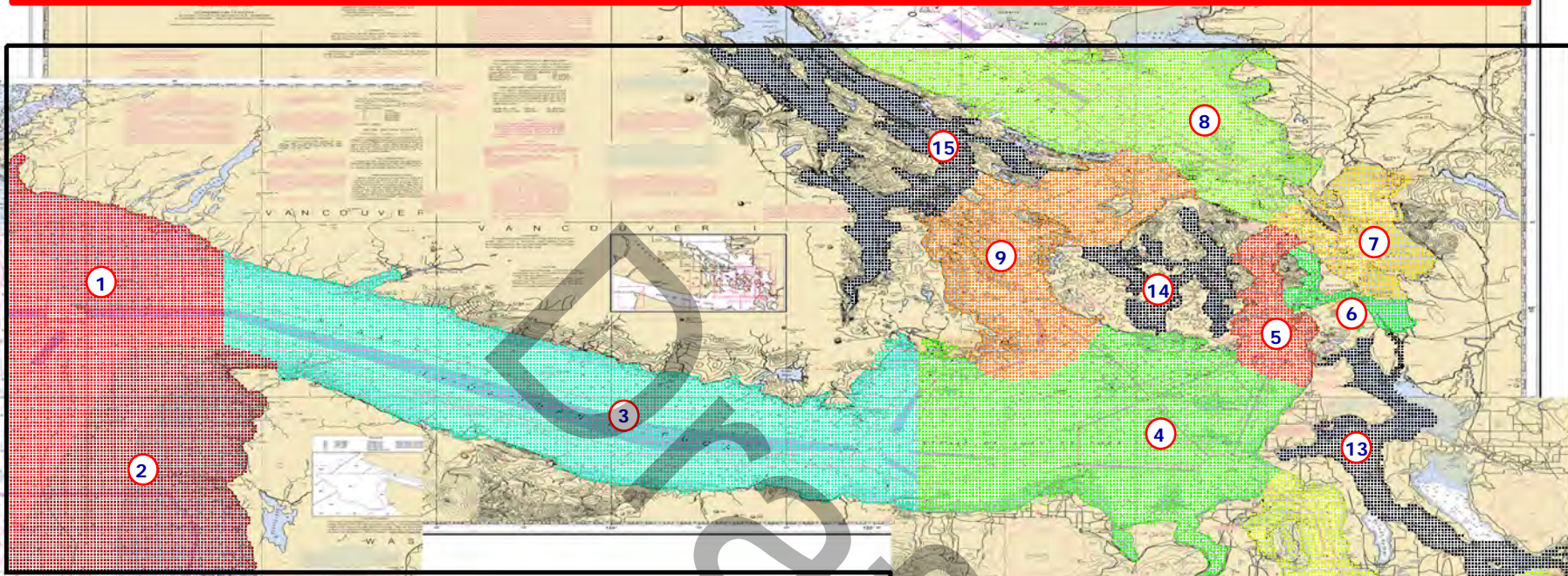
CASE T: Gateway, Kinder Morgan, Delta Port

GWU Personnel: Dr. J. Rene van Dorp

VCU Personnel: Dr. Jason R. W. Merrick

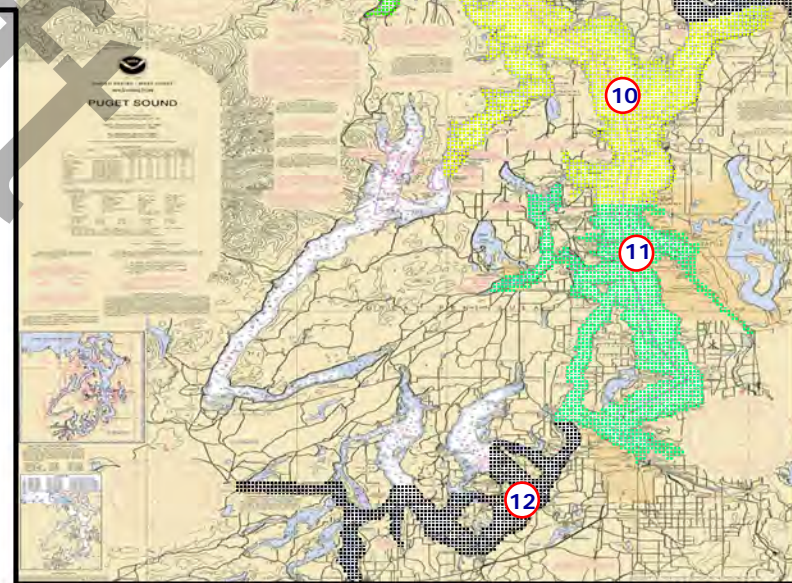
OCTOBER 9, 2013

DEFINITION OF 15 WATERWAY LOCATIONS



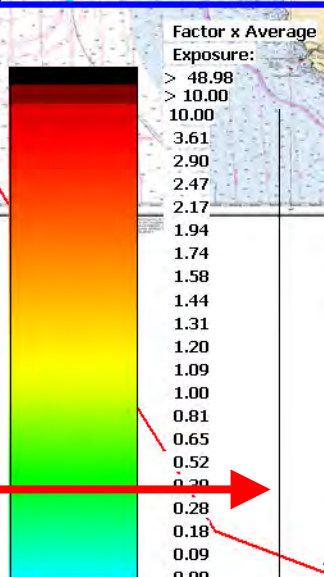
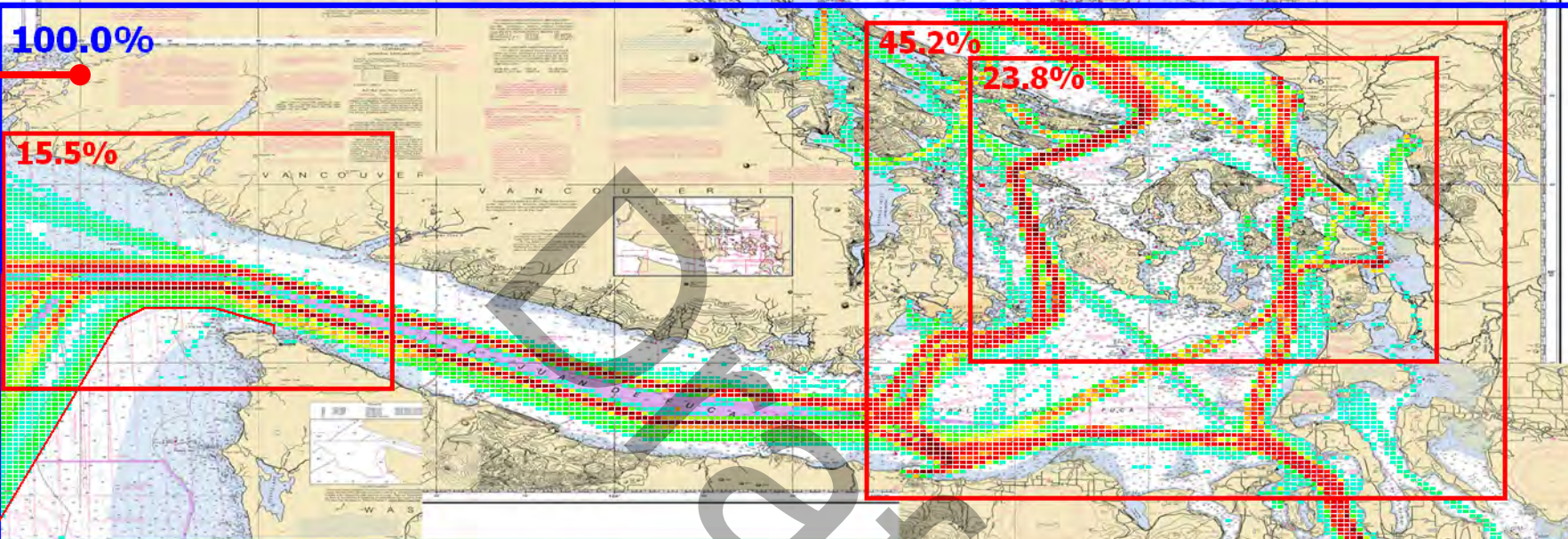
VTRA 2010 Waterway Locations

- | | |
|-----------------|-----------------|
| 1. Buoy J | 9. Harp/Boun. |
| 2. ATBA | 10. PS North |
| 3. WSJF | 11. PS South |
| 4. ESJF | 12. Tacoma |
| 5. Rosario | 13. Sar/Skagit |
| 6. Guemes | 14. SJ Islands |
| 7. Saddlebag | 15. Islands Trt |
| 8. Georgia Str. | |



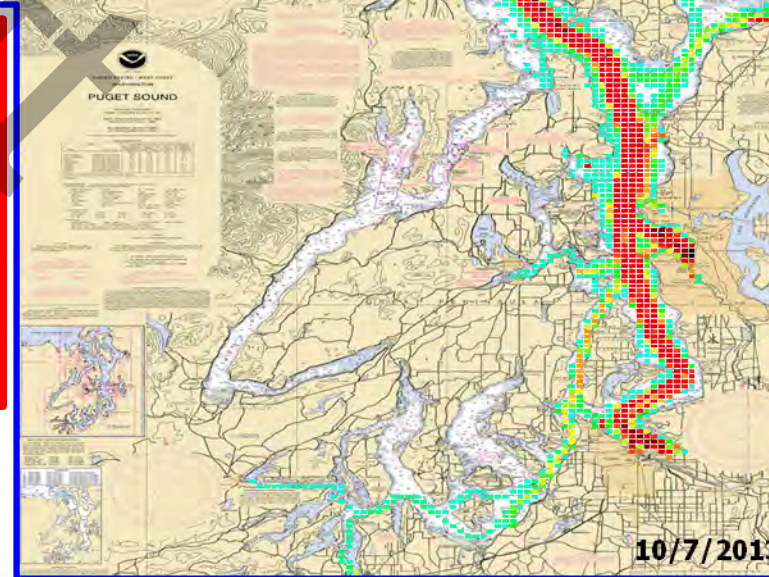
P: All FV TOTAL VESSEL TIME EXPOSURE (VTE)

P: VTRA 2010 - BASE CASE - All FV



- ### CASE P - ALL FV TRAFFIC DENSITY
- 32.6% - BULK CARGO
 - 20.2% - CONTAINERSHIP
 - 12.8% - OTHER CARGO
 - 19.3% - OIL BARGE
 - 08.8% - TANKER
 - 03.5% - CHEMICAL CARRIER
 - 02.7% - ATB
 - 00.0% - WHAT-IF FV

+
100.0% of 2010 Base Case
ALL FV - VTE



T: All FV TOTAL VESSEL TIME EXPOSURE (VTE)

T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348 - All FV

124.7%

19.9%

59.2%

33.5%

Factor x Average Exposure:

- > 48.98
- > 10.00
- 10.00
- 3.61
- 2.90
- 2.47
- 2.17
- 1.94
- 1.74
- 1.58
- 1.44
- 1.31
- 1.20
- 1.09
- 1.00
- 0.81
- 0.65
- 0.52
- 0.39
- 0.28
- 0.18
- 0.09
- 0.00

CASE T - ALL FV TRAFFIC DENSITY

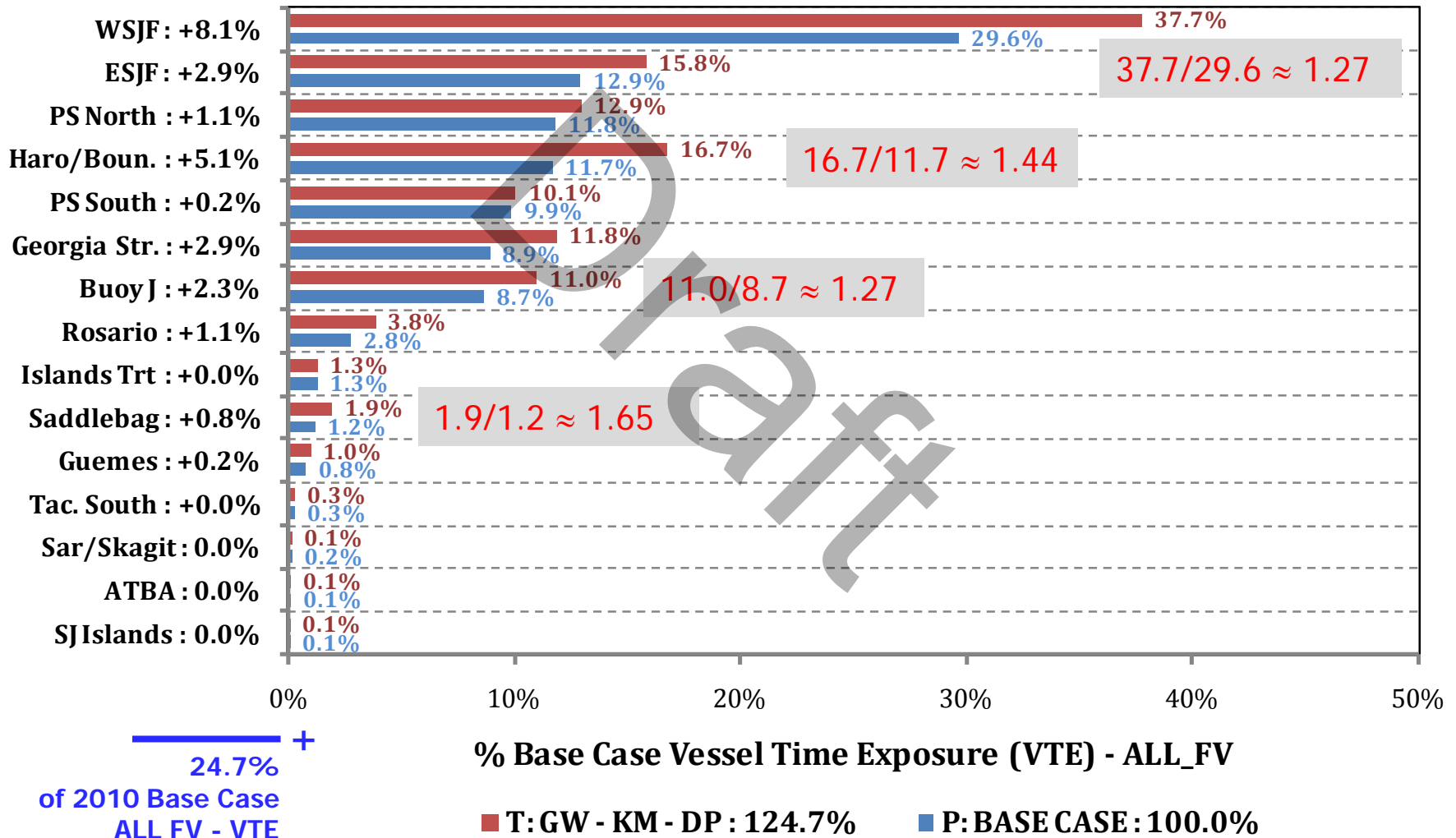
- 32.9% - BULK CARGO
- 20.4% - CONTAINERSHIP
- 12.9% - OTHER CARGO
- 19.1% - OIL BARGE
- 08.7% - TANKER
- 03.6% - CHEMICAL CARRIER
- 02.6% - ATB
- 24.4% - WHAT-IF FV

+
124.7% of 2010 Base Case
ALL FV - VTE

WATERWAY LOCATION

VESSEL TIME EXPOSURE ANALYSIS – ALL FOCUS VESSELS

% Base Case Vessel Time Exposure (VTE) - ALL_FV



T: WHAT-IF FV TOTAL VESSEL TIME EXPOSURE (VTE)

T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348

24.4%

4.5%

13.5%

9.2%

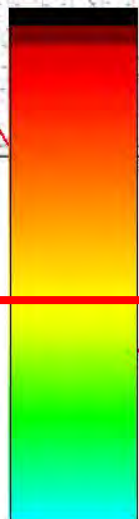
CASE T - ALL FV TRAFFIC DENSITY

- 12.5% - BULK CARGO
- 01.8% - CONTAINERSHIP
- 07.3% - TANKER
- 02.7% - OILBARGE

+
24.4% of 2010 Base Case
ALL FV - VTE

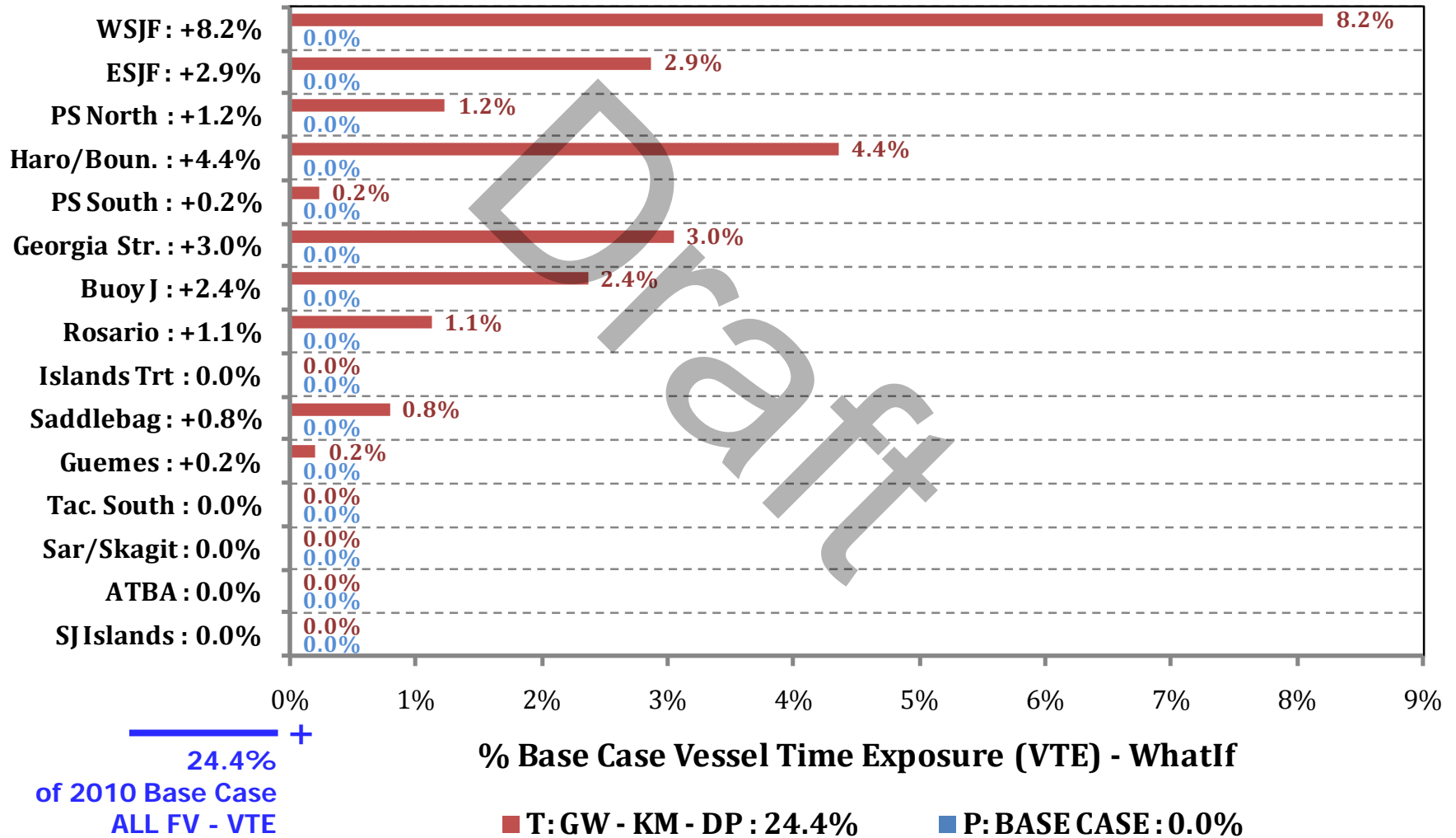
Factor x Average Exposure:

- > 48.98
- > 10.00
- 10.00
- 3.61
- 2.90
- 2.47
- 2.17
- 1.94
- 1.74
- 1.58
- 1.44
- 1.31
- 1.20
- 1.09
- 1.00
- 0.81
- 0.65
- 0.52
- 0.39
- 0.28
- 0.18
- 0.09
- 0.00



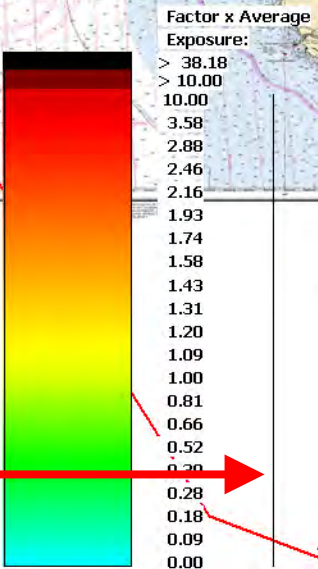
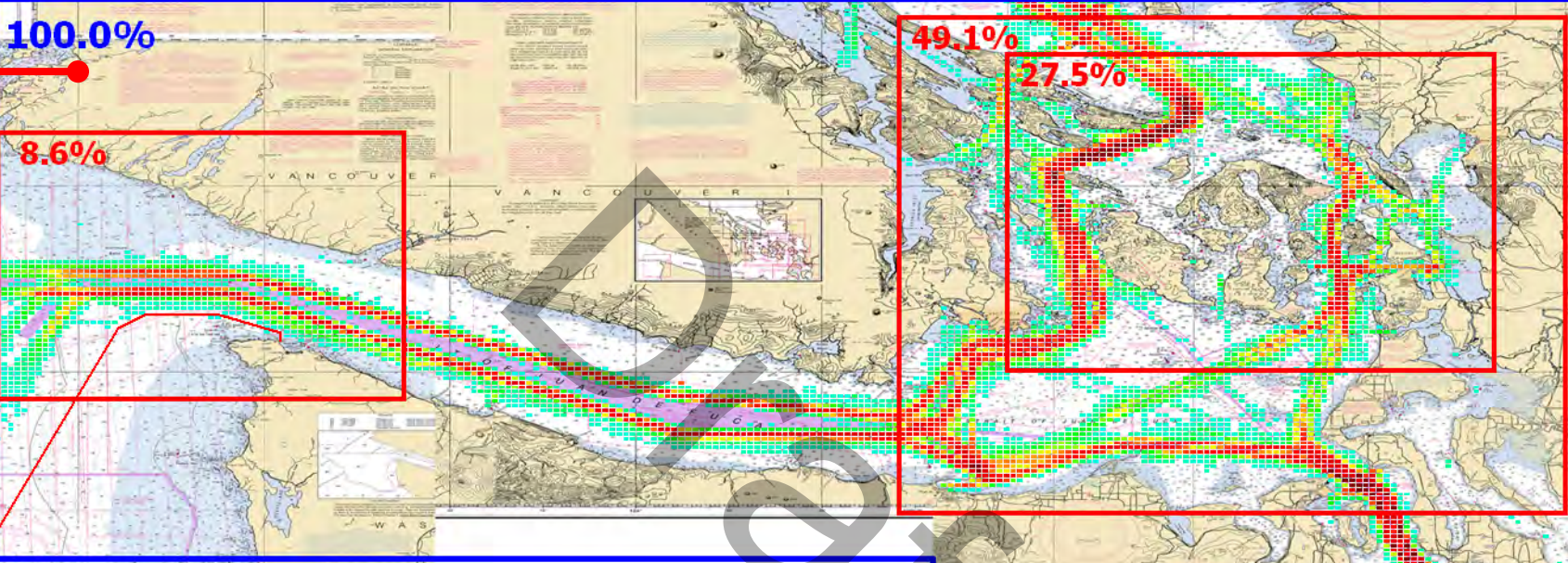
WATERWAY LOCATION VESSEL TIME EXPOSURE ANALYSIS – What If FV

% Base Case Vessel Time Exposure (VTE) - WhatIf



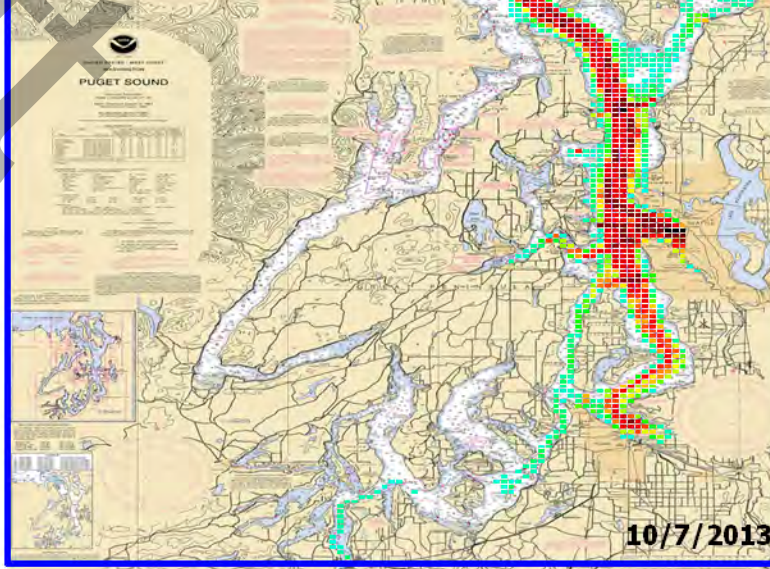
P: ALL FV POTENTIAL COLLISION EXPOSURE (PCE)

P: VTRA 2010 - BASE CASE - All FV



- CASE P : POT. COLL. EXPOSURE (PCE)**
- 26.2% - BULK CARGO
 - 31.0% - CONTAINERSHIP
 - 13.9% - OTHER CARGO
 - 16.9% - OIL BARGE
 - 07.1% - TANKER
 - 02.9% - CHEMICAL CARRIER
 - 01.9% - ATB
 - 00.0% - WHAT-IF FV

100.0% of 2010 Base Case ALL FV - CE



T: All FV POTENTIAL COLLISION EXPOSURE (PCE)



T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348 - All FV

141.1%

13.6%

74.0%

44.5%

Factor x Average Exposure:

- > 38.18
- > 10.00
- 10.00
- 3.58
- 2.88
- 2.46
- 2.16
- 1.93
- 1.74
- 1.58
- 1.43
- 1.31
- 1.20
- 1.09
- 1.00
- 0.81
- 0.66
- 0.52
- 0.39
- 0.28
- 0.18
- 0.09
- 0.00

CASE T : POT. COLL. EXPOSURE (PCE)

- 29.7% - BULK CARGO
- 33.4% - CONTAINERSHIP
- 15.1% - OTHER CARGO
- 17.1% - OIL BARGE
- 08.0% - TANKER
- 03.5% - CHEMICAL CARRIER
- 01.9% - ATB
- 32.5% - WHAT-IF FV

+

141.1% of 2010 Base Case

ALL FV - CE

T: WHAT-IF FV POTENTIAL COLLISION EXPOSURE (PCE)



T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348

32.5%

3.0%

20.9%

14.5%

Factor x Average Exposure:

- > 38.18
- > 10.00
- 10.00
- 3.58
- 2.88
- 2.46
- 2.16
- 1.93
- 1.74
- 1.58
- 1.43
- 1.31
- 1.20
- 1.09
- 1.00
- 0.81
- 0.66
- 0.52
- 0.39
- 0.28
- 0.18
- 0.09
- 0.00

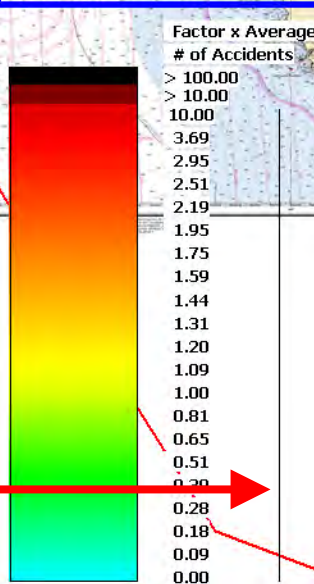
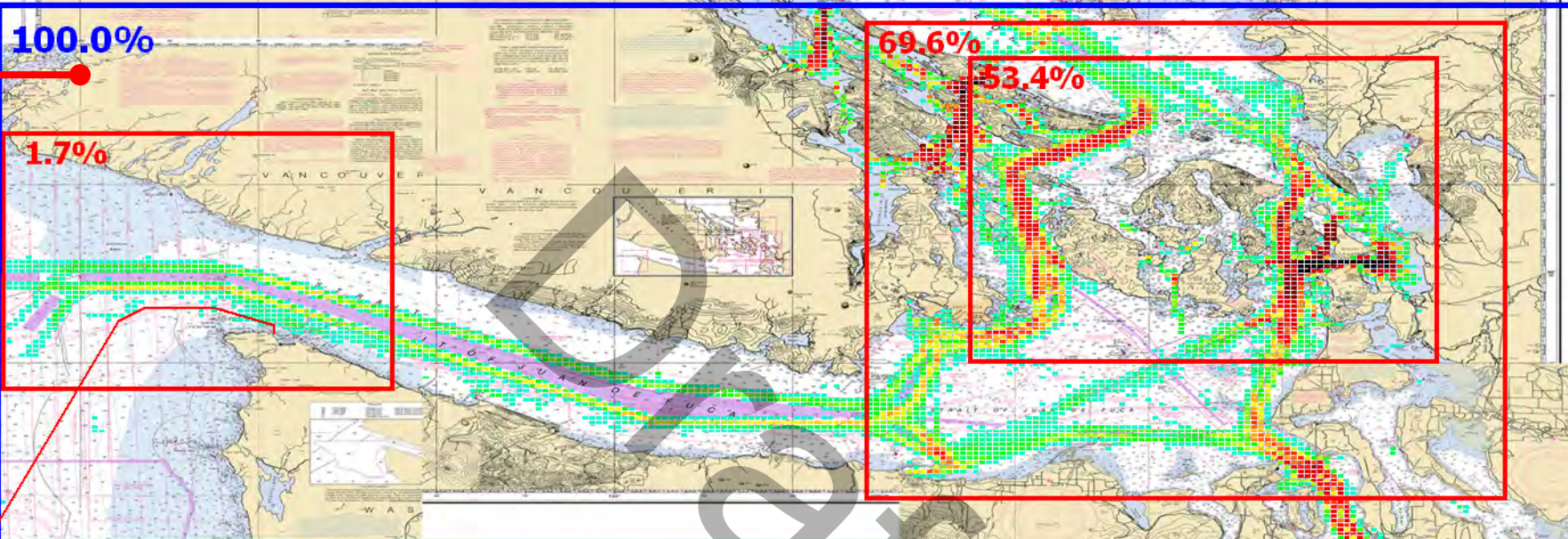
CASE T : POT. COLL. EXPOSURE (PCE)

- 15.3% - BULK CARGO
- 03.0% - CONTAINERSHIP
- 10.6% - TANKER
- 03.7% - OILBARGE

— +
32.5% of 2010 Base Case
ALL FV - CE

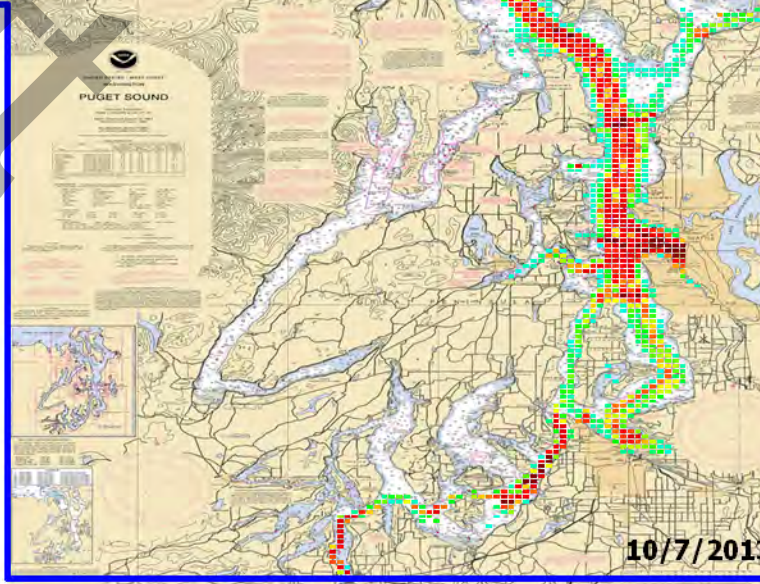
P: ALL FV POTENTIAL COLLISION FREQUENCY (PCF)

P: VTRA 2010 - BASE CASE - All FV



- CASE P: POTENTIAL COLL. FREQ. (PCF)**
- 09.6% - BULK CARGO
 - 06.0% - CONTAINERSHIP
 - 04.7% - OTHER CARGO
 - 56.9% - OIL BARGE
 - 07.2% - TANKER
 - 13.9% - CHEMICAL CARRIER
 - 01.8% - ATB
 - 00.0% - WHAT-IF FV

100.0% of 2010 Base Case ALL FV - PCF



T: ALL FV POTENTIAL COLLISION FREQUENCY (PCF)

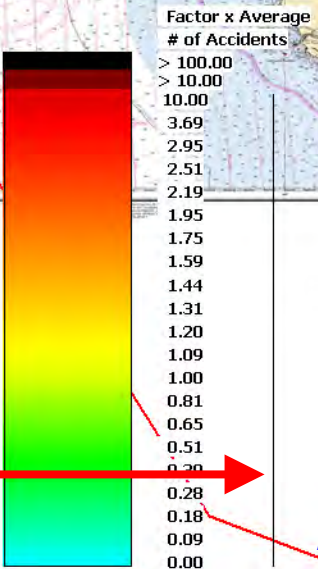
T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348 - All FV

120.6%

2.7%

85.8%

67.7%



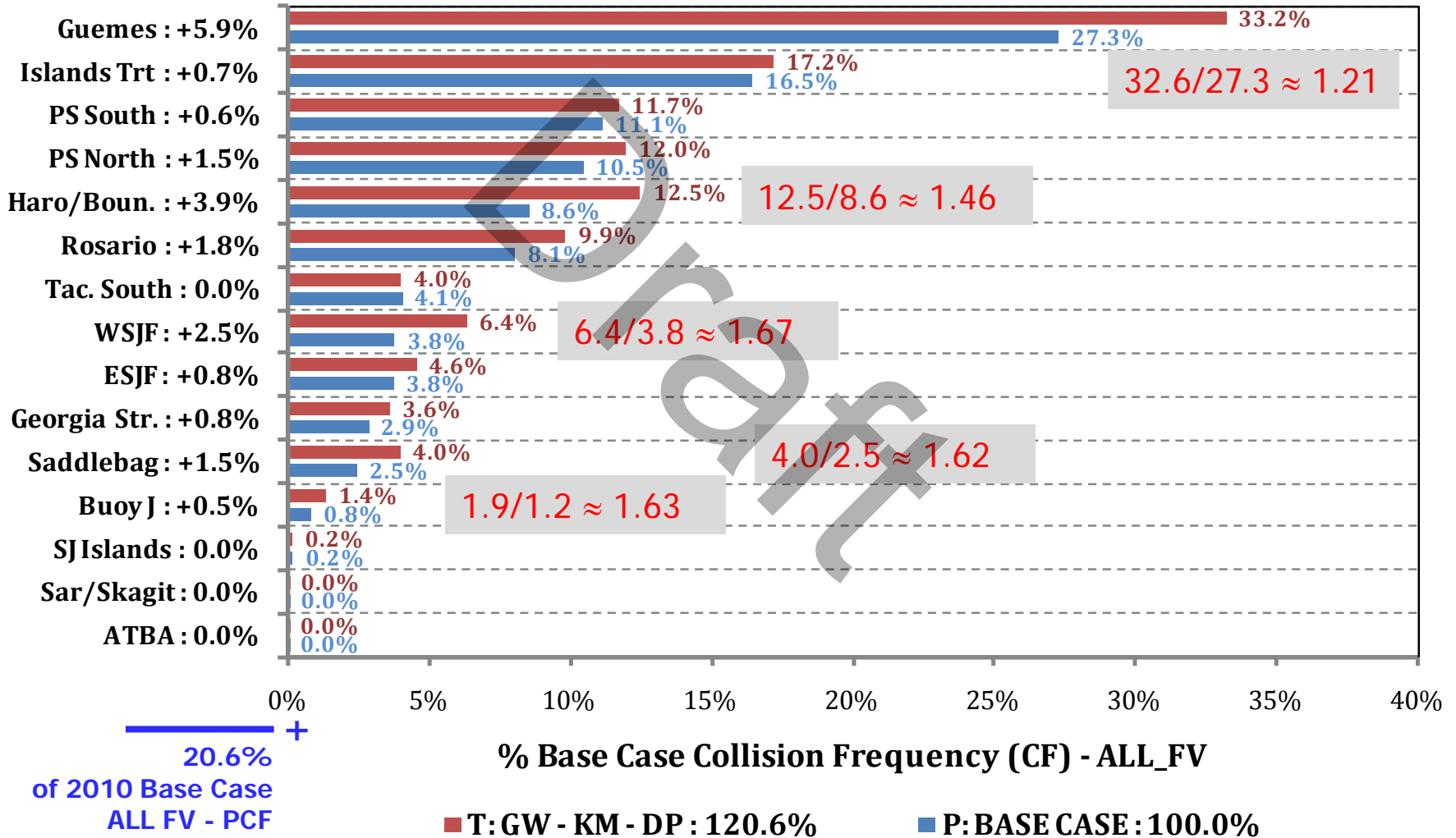
- CASE T: POTENTIAL COLL. FREQ. (PCF)**
- 10.3% - BULK CARGO
 - 06.3% - CONTAINERSHIP
 - 04.6% - OTHER CARGO
 - 54.5% - OIL BARGE
 - 08.6% - TANKER
 - 15.9% - CHEMICAL CARRIER
 - 02.0% - ATB
 - 18.4% - WHAT-IF FV

+ 120.6% of 2010 Base Case ALL FV - PCF

WATERWAY LOCATION

Potential Collision Freq. Comparison – ALL FV

% Base Case Collision Frequency - ALL_FV



T: WHAT-IF FV POTENTIAL COLLISION FREQUENCY (PCF)



T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348

18.4%

0.7%

14.6%

13.1%

Factor x Average
of Accidents

- > 100.00
- > 10.00
- 10.00
- 3.69
- 2.95
- 2.51
- 2.19
- 1.95
- 1.75
- 1.59
- 1.44
- 1.31
- 1.18
- 1.09
- 1.00
- 0.81
- 0.65
- 0.51
- 0.39
- 0.28
- 0.18
- 0.09
- 0.00

CASE T: POTENTIAL COLL. FREQ. (PCF)

- 03.6% - BULK CARGO
- 00.7% - CONTAINERSHIP
- 03.1% - TANKER
- 10.9% - OILBARGE

+

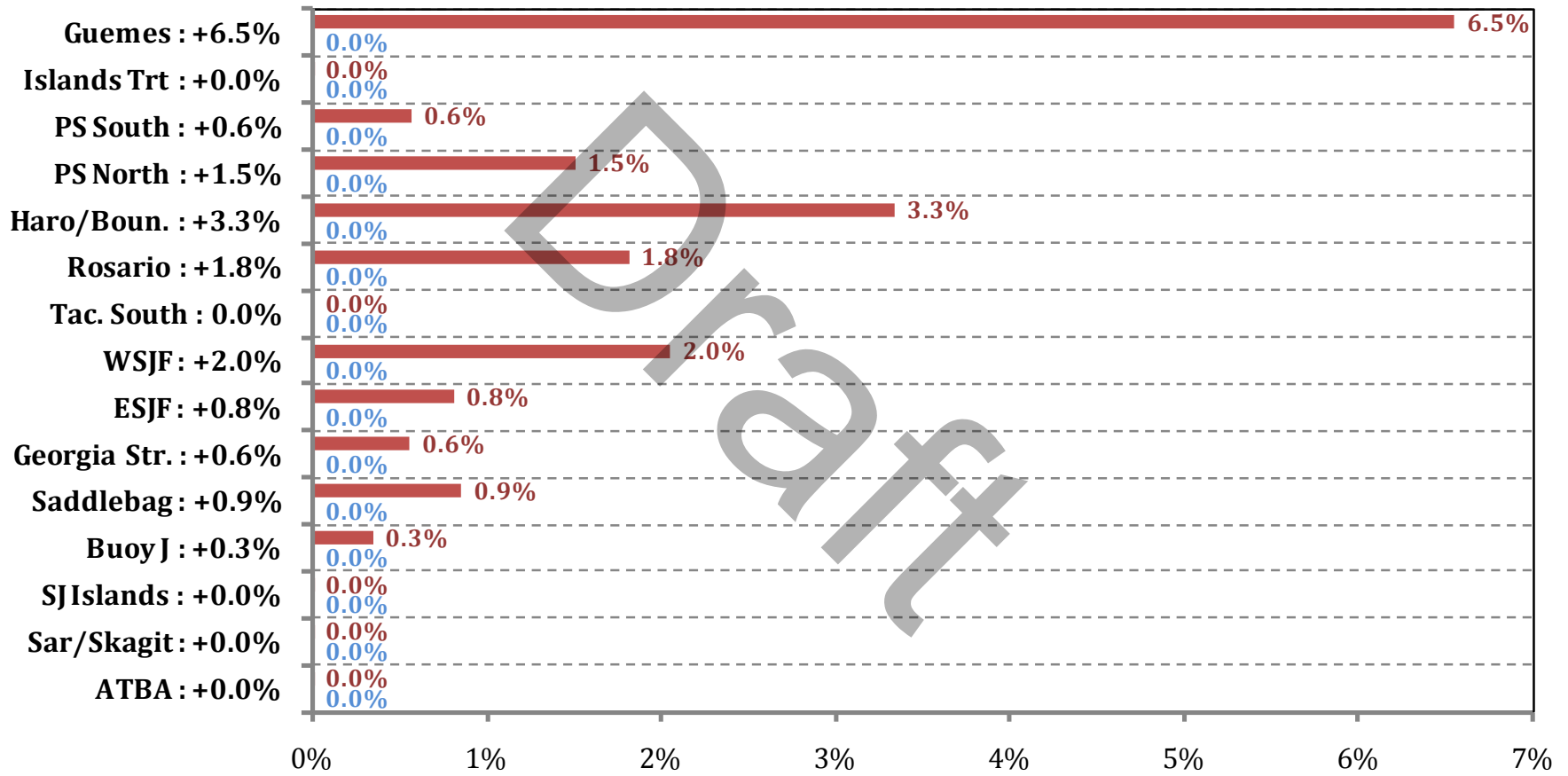
18.4% of 2010 Base Case


ALL FV - PCF

WATERWAY LOCATION

Potential Collision Freq. Comparison – WHAT-IF FV

% Base Case Collision Frequency - WhatIf





 18.4%

 of 2010 Base Case

 ALL FV - PCF

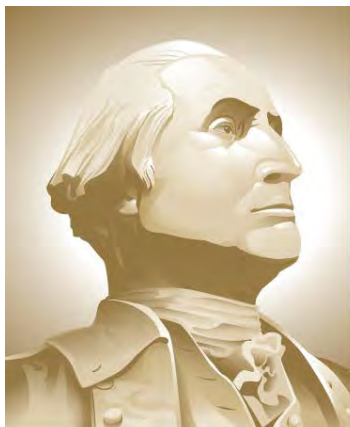
% Base Case Collision Frequency (CF) - WhatIf

 T: GW - KM - DP : 18.4%

 P: BASE CASE : 0.0%

VTRA 2010 CASE T RESULTS – COLLISION OIL (CARGO + FUEL), CARGO AND FUEL OIL GEOGRAPHIC PROFILES

Presentation by: J. Rene van Dorp



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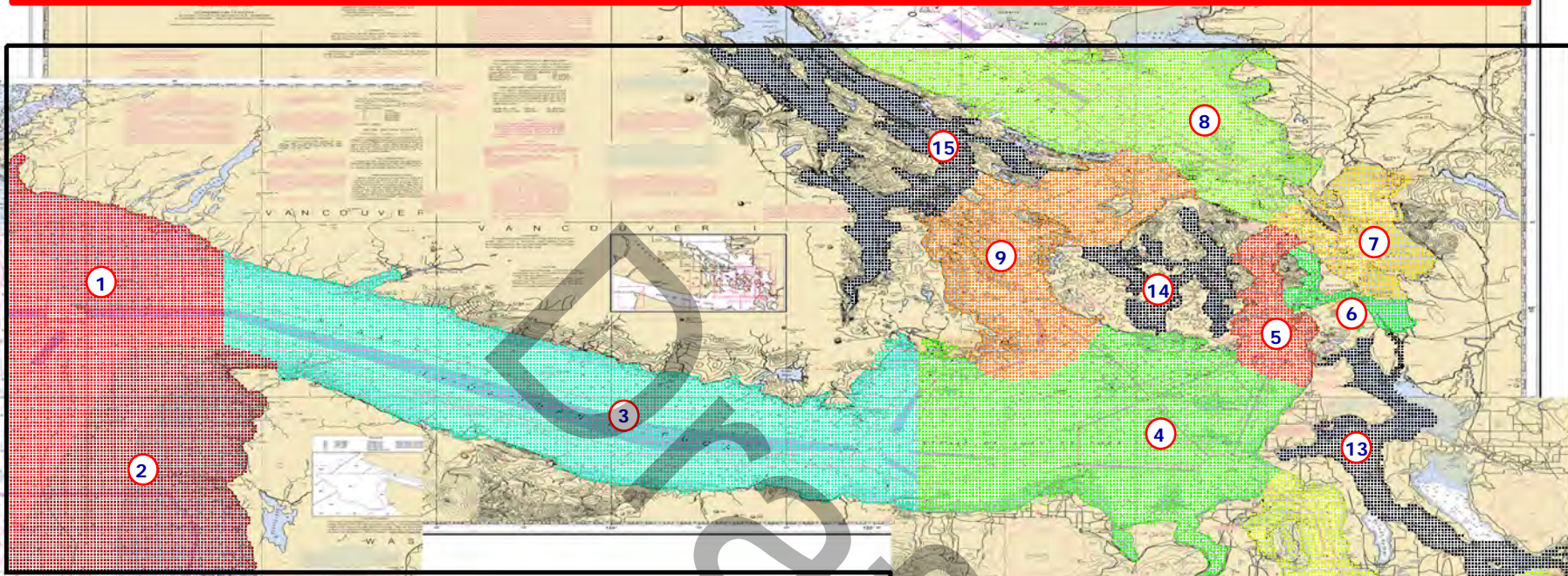
CASE T: Gateway, Kinder Morgan, Delta Port

GWU Personnel: Dr. J. Rene van Dorp

VCU Personnel: Dr. Jason R. W. Merrick

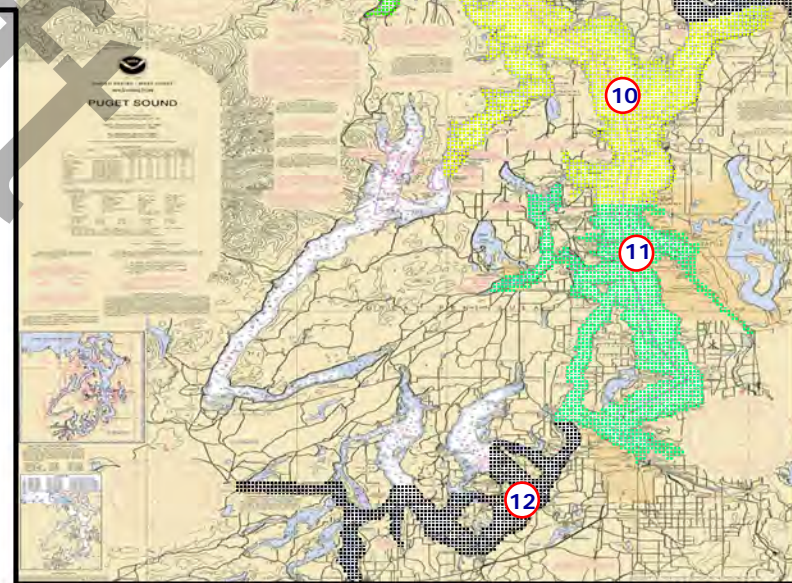
OCTOBER 9, 2013

DEFINITION OF 15 WATERWAY LOCATIONS



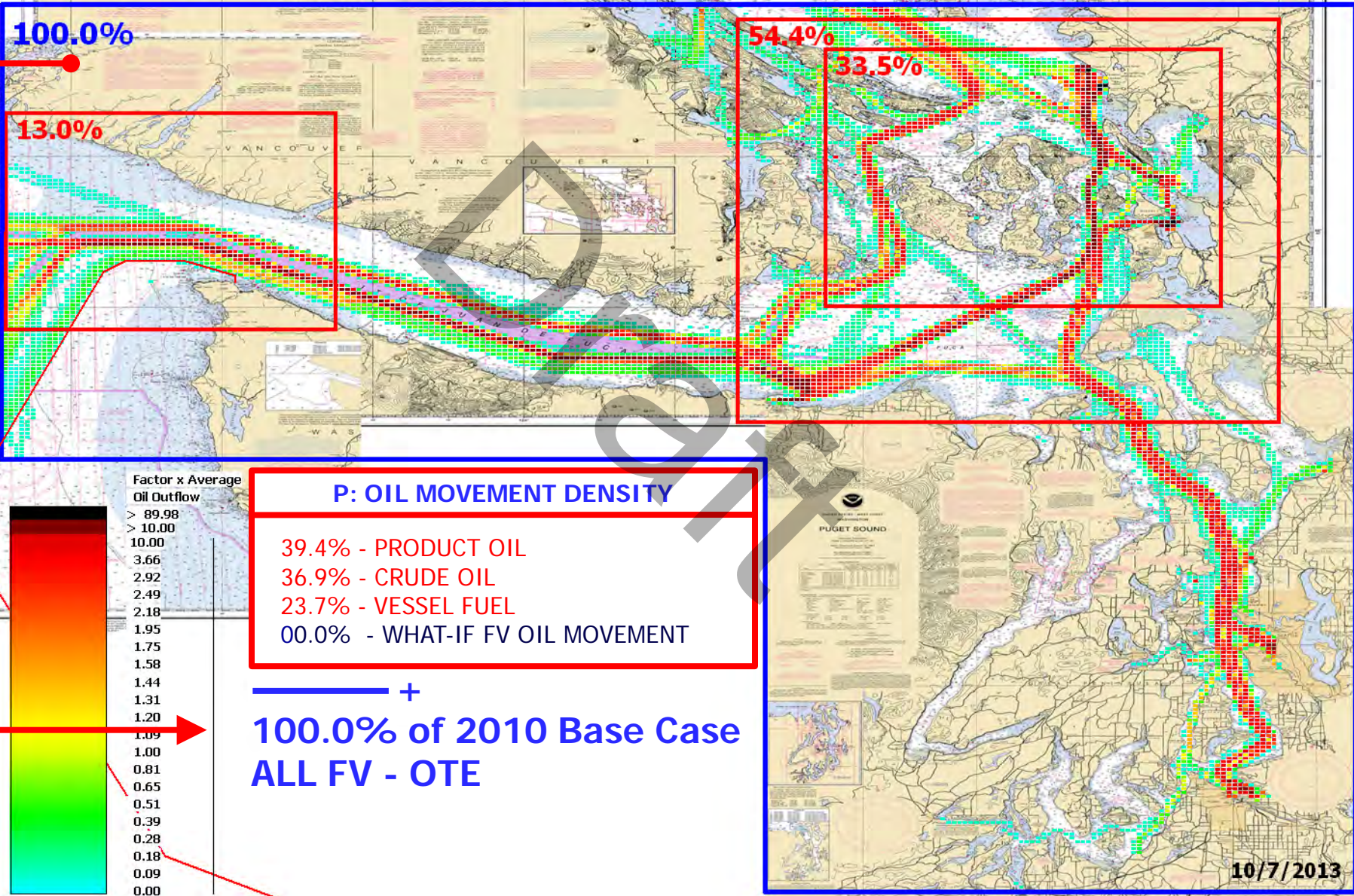
VTRA 2010 Waterway Locations

- | | |
|-----------------|-----------------|
| 1. Buoy J | 9. Harp/Boun. |
| 2. ATBA | 10. PS North |
| 3. WSJF | 11. PS South |
| 4. ESJF | 12. Tacoma |
| 5. Rosario | 13. Sar/Skagit |
| 6. Guemes | 14. SJ Islands |
| 7. Saddlebag | 15. Islands Trt |
| 8. Georgia Str. | |



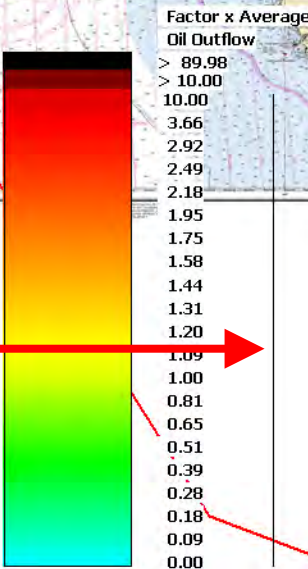
P: ALL FV ALL OIL MOVEMENT

P: VTRA 2010 - BASE CASE - All FV



P: OIL MOVEMENT DENSITY

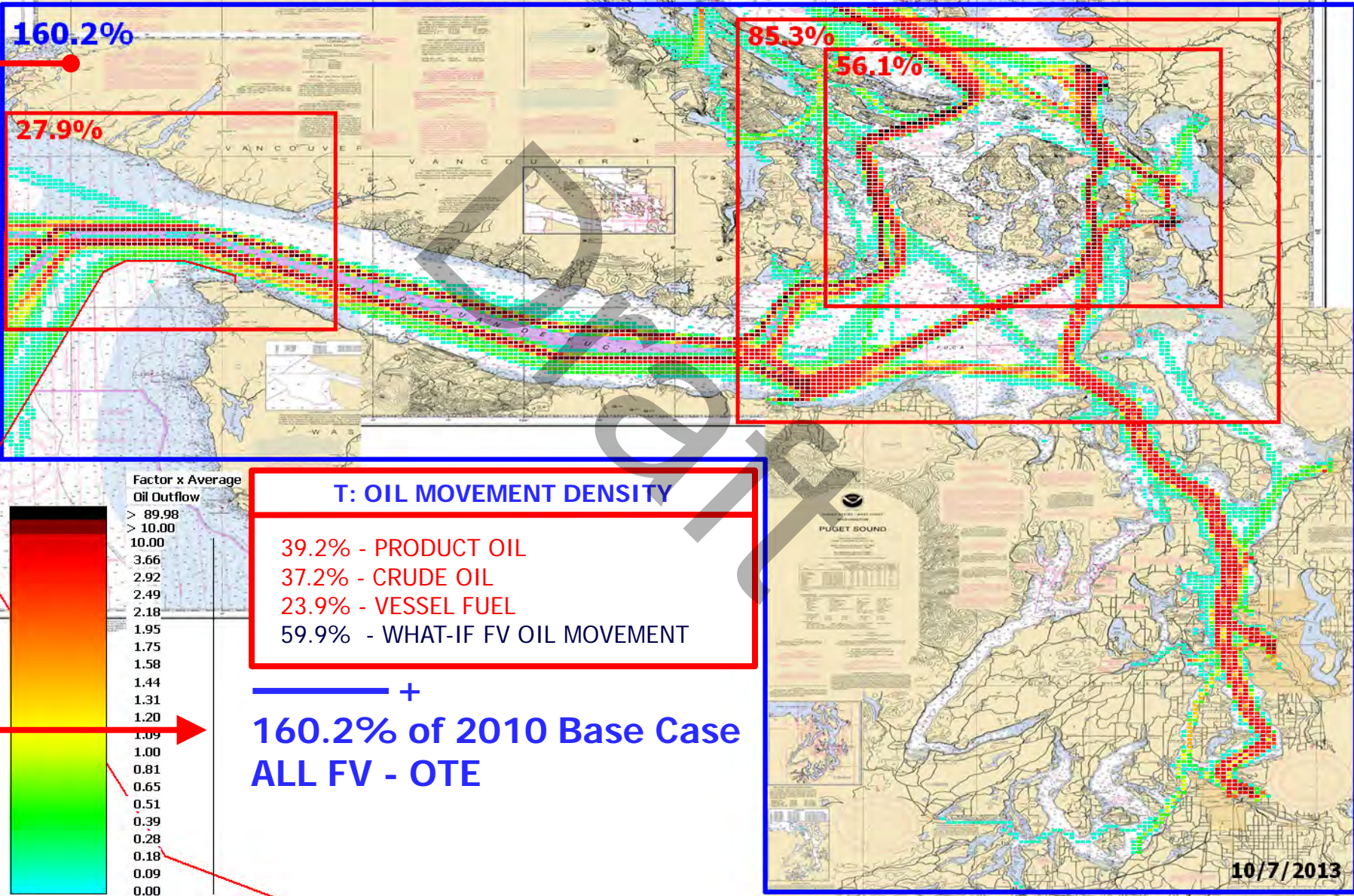
- 39.4% - PRODUCT OIL
- 36.9% - CRUDE OIL
- 23.7% - VESSEL FUEL
- 00.0% - WHAT-IF FV OIL MOVEMENT



— +
100.0% of 2010 Base Case
ALL FV - OTE

T: ALL FV ALL OIL MOVEMENT

T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348 - All FV

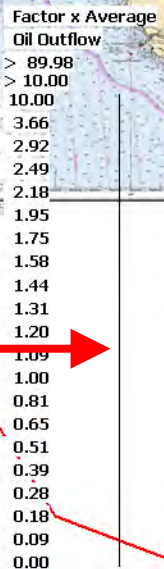


160.2%

27.9%

85.3%

56.1%



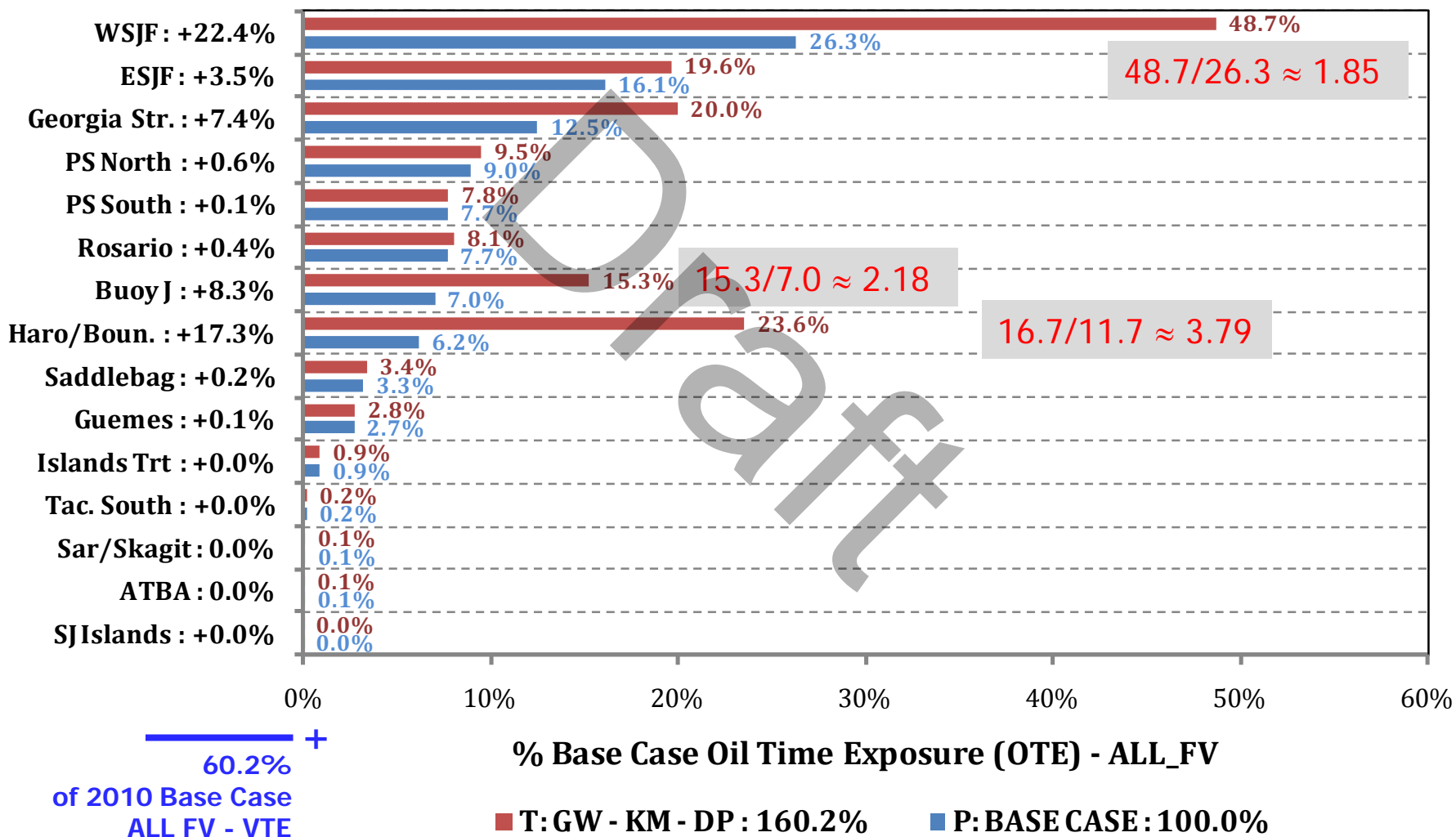
T: OIL MOVEMENT DENSITY

39.2% - PRODUCT OIL
37.2% - CRUDE OIL
23.9% - VESSEL FUEL
59.9% - WHAT-IF FV OIL MOVEMENT

+
160.2% of 2010 Base Case
ALL FV - OTE

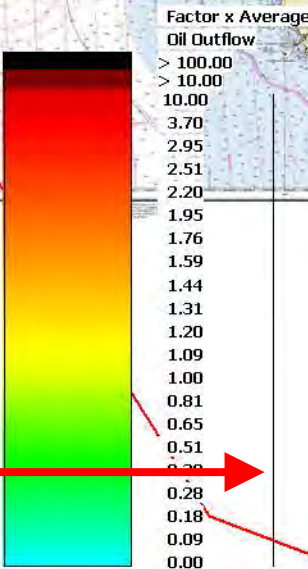
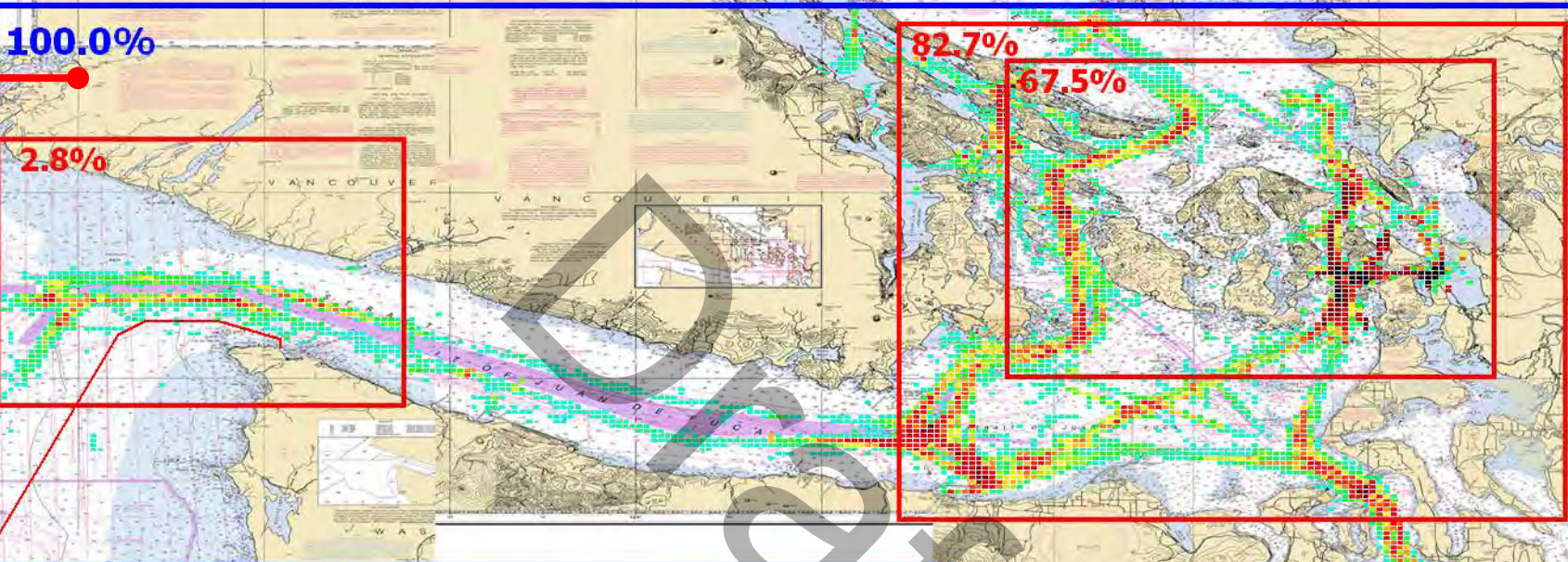
WATERWAY LOCATION OIL TIME EXPOSURE COMPARISON (P+C+F)

% Base Case Oil Time Exposure - ALL_FV



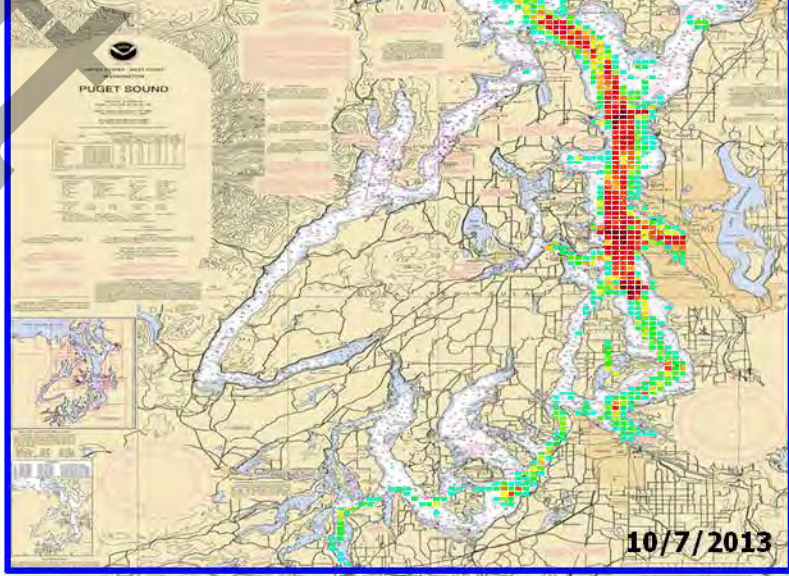
P: ALL FV POTENTIAL COLLISION OIL (FUEL + CARGO) LOSS (PCO)

P: VTRA 2010 - BASE CASE - All FV



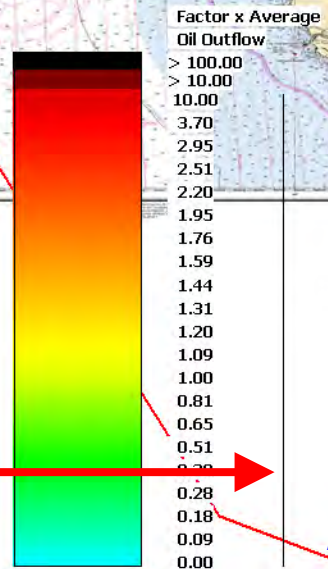
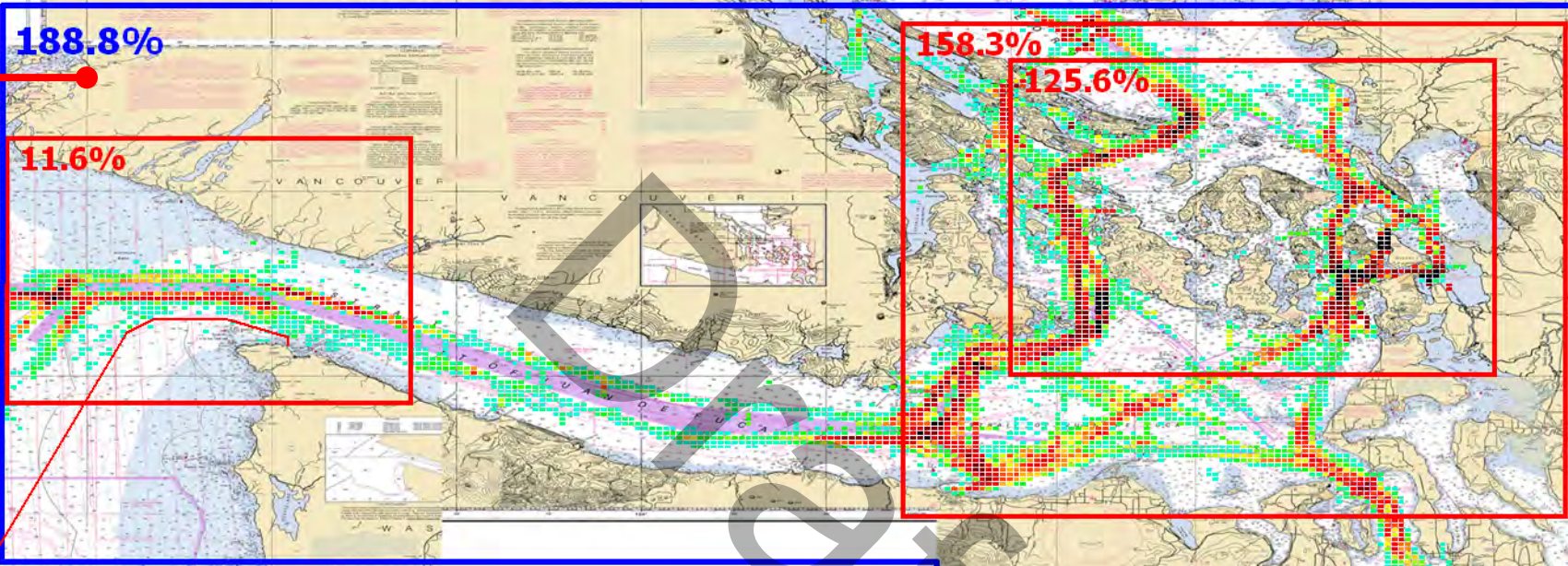
- P: POTENTIAL COLL. OIL LOSS (PCO)**
- 03.7% - BULK CARGO
 - 04.1% - CONTAINERSHIP
 - 01.4% - OTHER CARGO
 - 21.4% - OIL BARGE
 - 54.2% - TANKER
 - 13.3% - CHEMICAL CARRIER
 - 02.6% - ATB
 - 00.0% - WHAT-IF FV

100.0% of 2010 Base Case ALL FV – PCO



T: ALL FV POTENTIAL COLLISION OIL (FUEL + CARGO) LOSS (PCO)

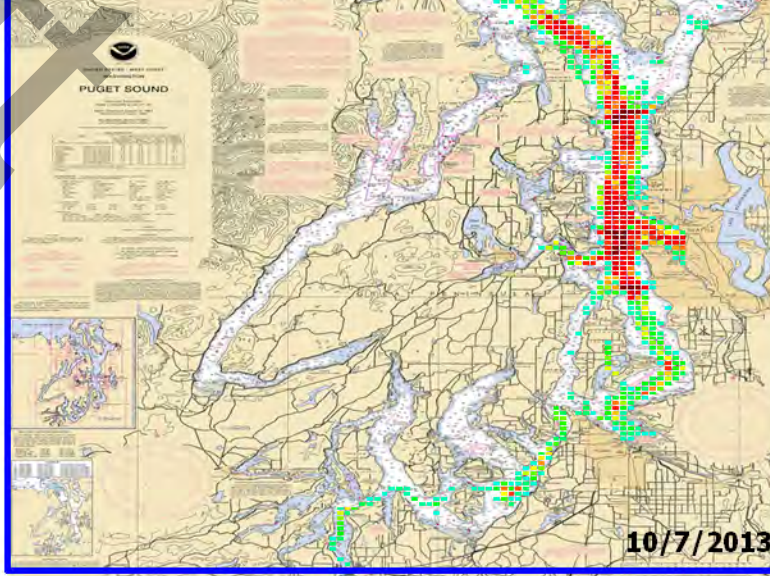
T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348 - All FV



T: POTENTIAL COLL. OIL LOSS (PCO)

- 04.9% - BULK CARGO
- 05.6% - CONTAINERSHIP
- 02.4% - OTHER CARGO
- 18.1% - OIL BARGE
- 83.6% - TANKER
- 09.2% - CHEMICAL CARRIER
- 03.2% - ATB
- 62.0% - WHAT-IF FV

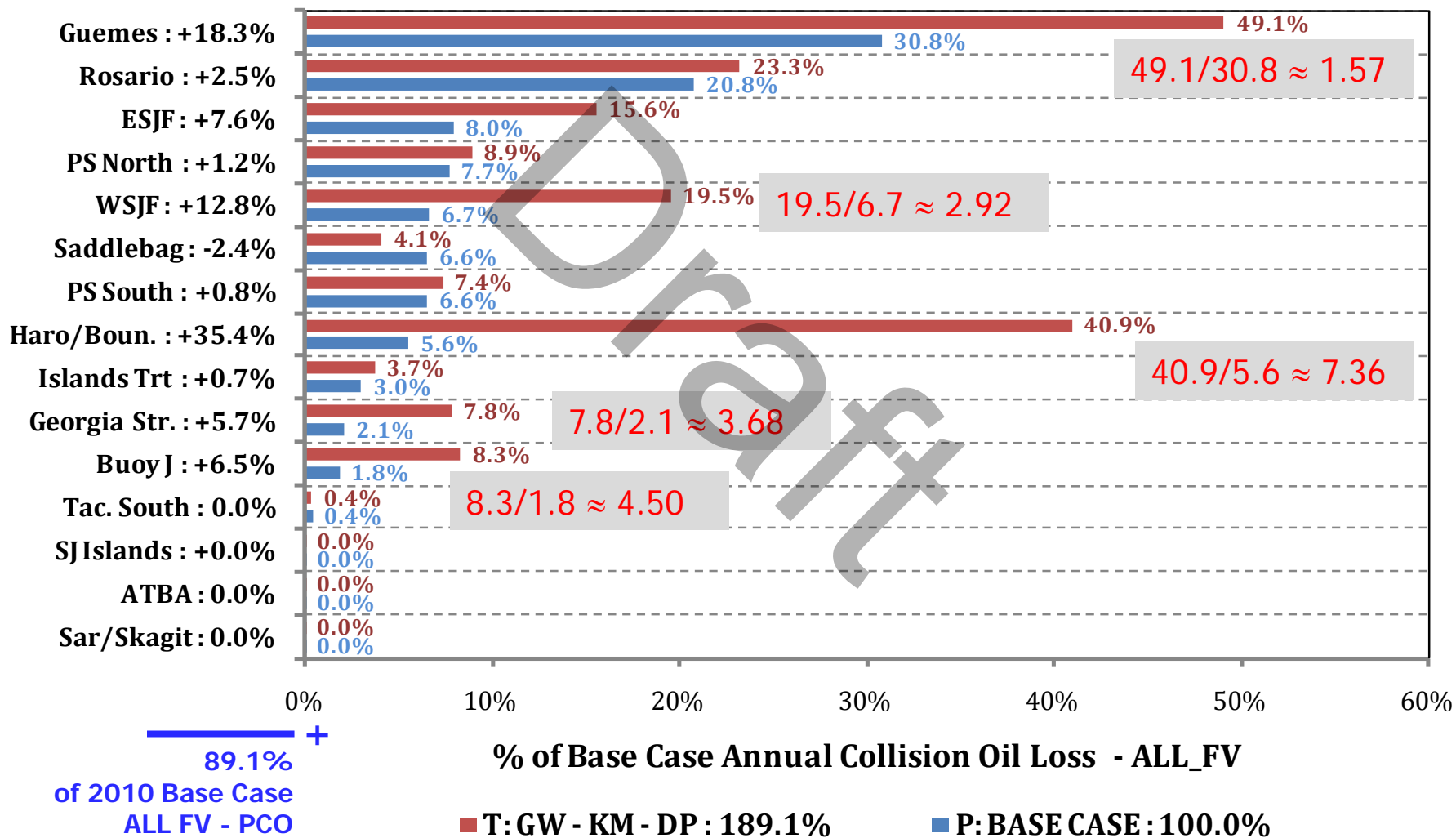
188.8% of 2010 Base Case ALL FV – PCO



WATERWAY LOCATION

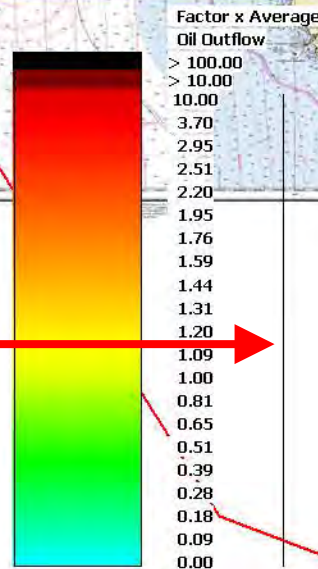
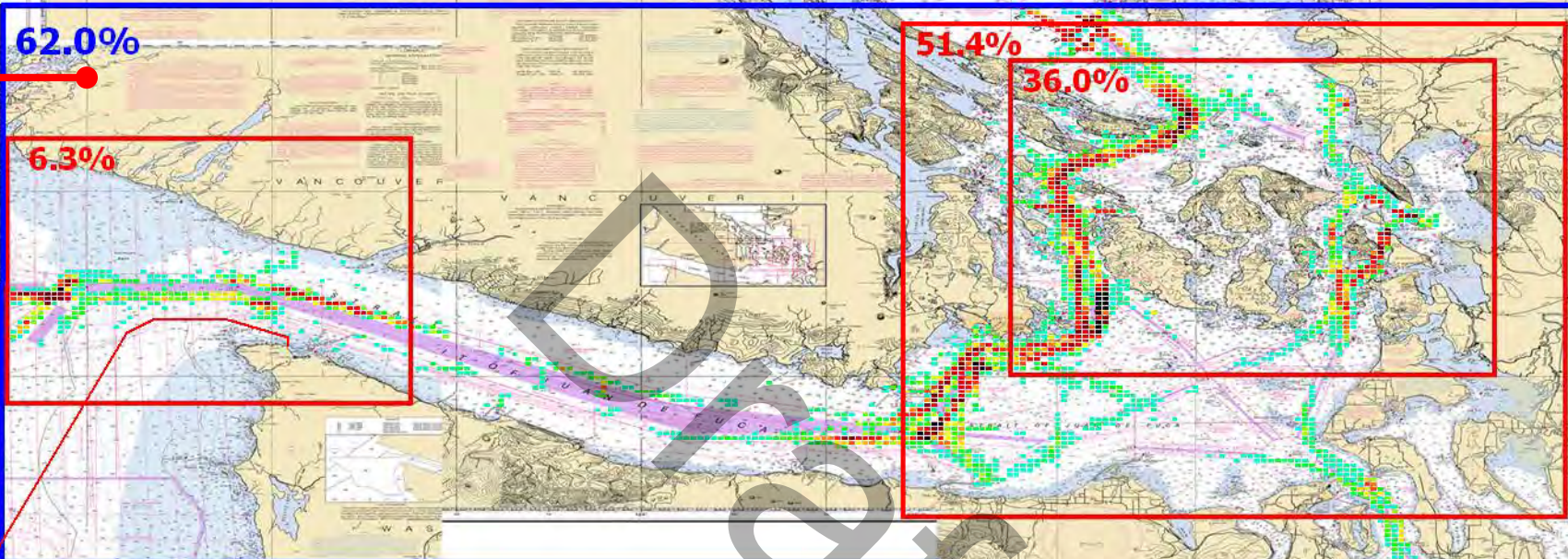
Potential Collision Oil Loss Comparison – ALL FV

% Base Case Collision Oil Loss - ALL_FV



T: WHAT-IF FV POTENTIAL COLLISION OIL (FUEL+CARGO) LOSS (PCO)

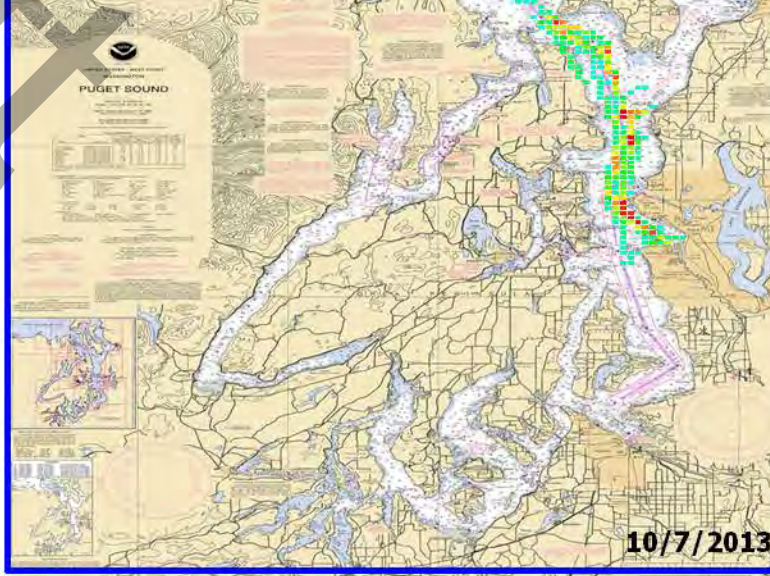
T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348



T: POTENTIAL COLL. OIL LOSS (PCO)

- 15.2% - BULKCARRIER
- 00.7% - CONTAINERSHIP
- 41.3% - OIL TANKER
- 04.8% - OIL BARGE

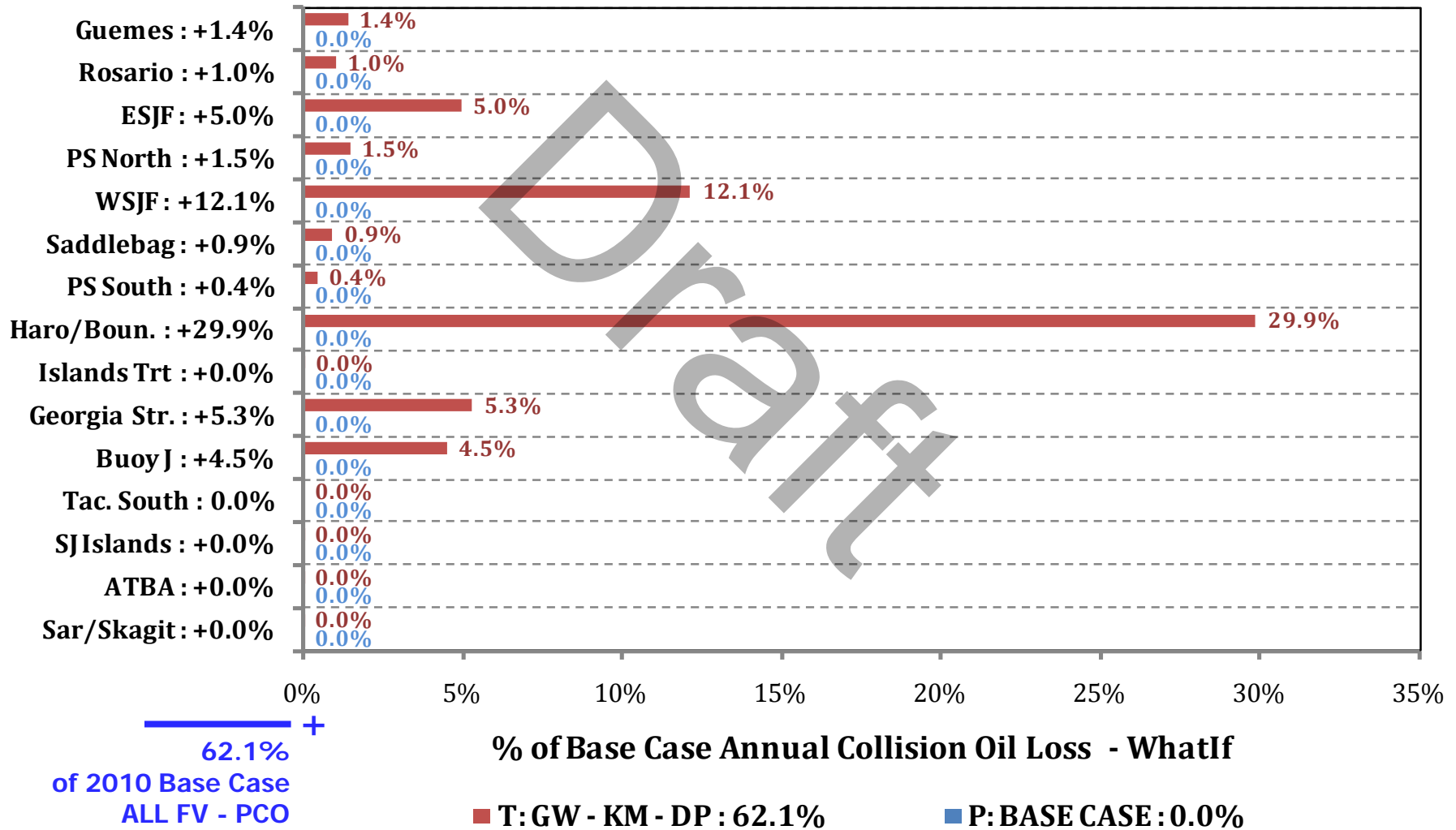
62.0% of 2010 Base Case ALL FV – PCO



WATERWAY LOCATION

Potential Collision Oil Loss Comparison – WHAT-IF FV

% Base Case Collision Oil Loss - WhatIf



P: ALL FV POTENTIAL COLLISION FUEL OIL LOSS (PCFO)

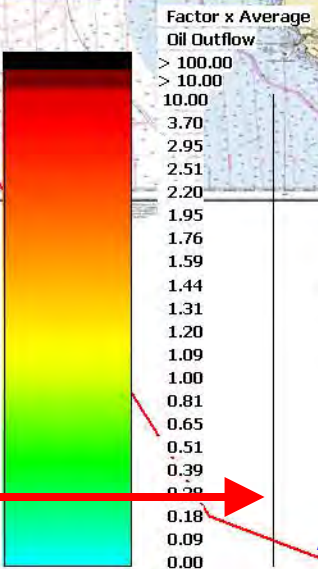
P: VTRA 2010 - BASE CASE

13.2%

0.5%

8.8%

5.6%

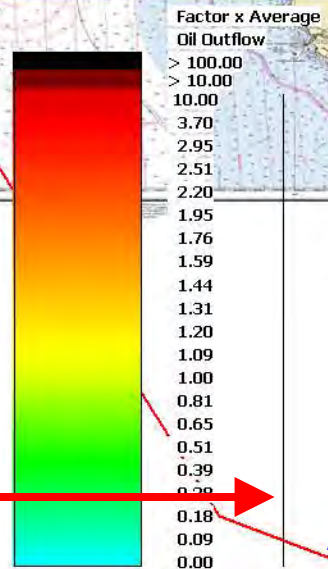
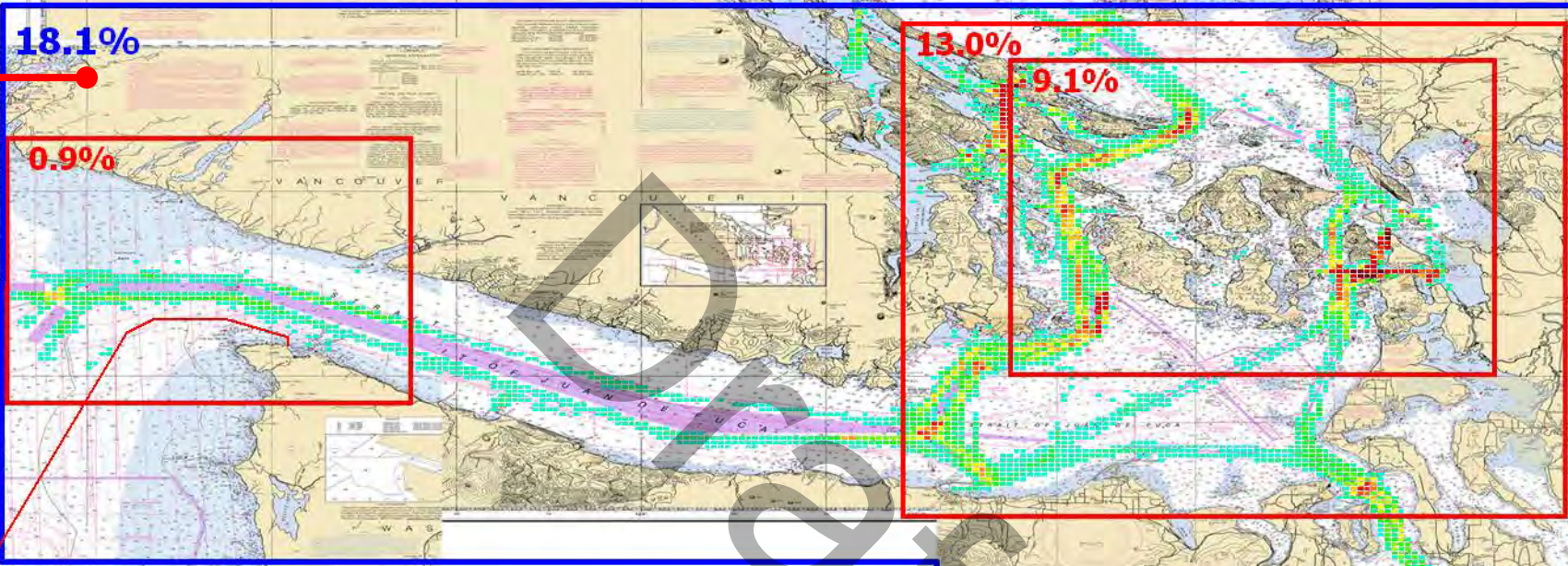


- P: POT. COLL. FUEL OIL LOSS (PCFO)**
- 2.1% - BULK CARGO
 - 2.6% - CONTAINERSHIP
 - 1.0% - OTHER CARGO
 - 5.0% - OIL BARGE
 - 1.2% - TANKER
 - 1.0% - CHEMICAL CARRIER
 - 0.2% - ATB
 - 0.0% - WHAT-IF FV

+
13.2% of 2010 Base Case
ALL FV - PCO

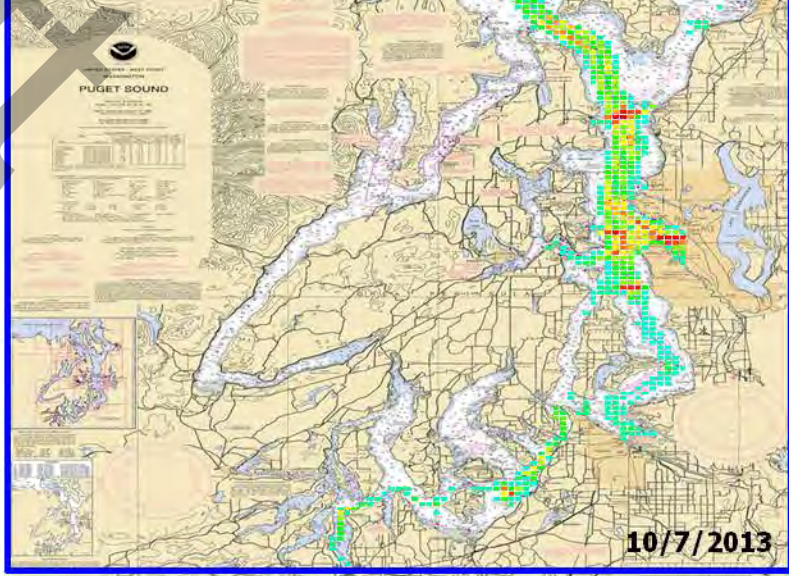
T: ALL FV POTENTIAL COLLISION FUEL OIL LOSS (PCFO)

T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348



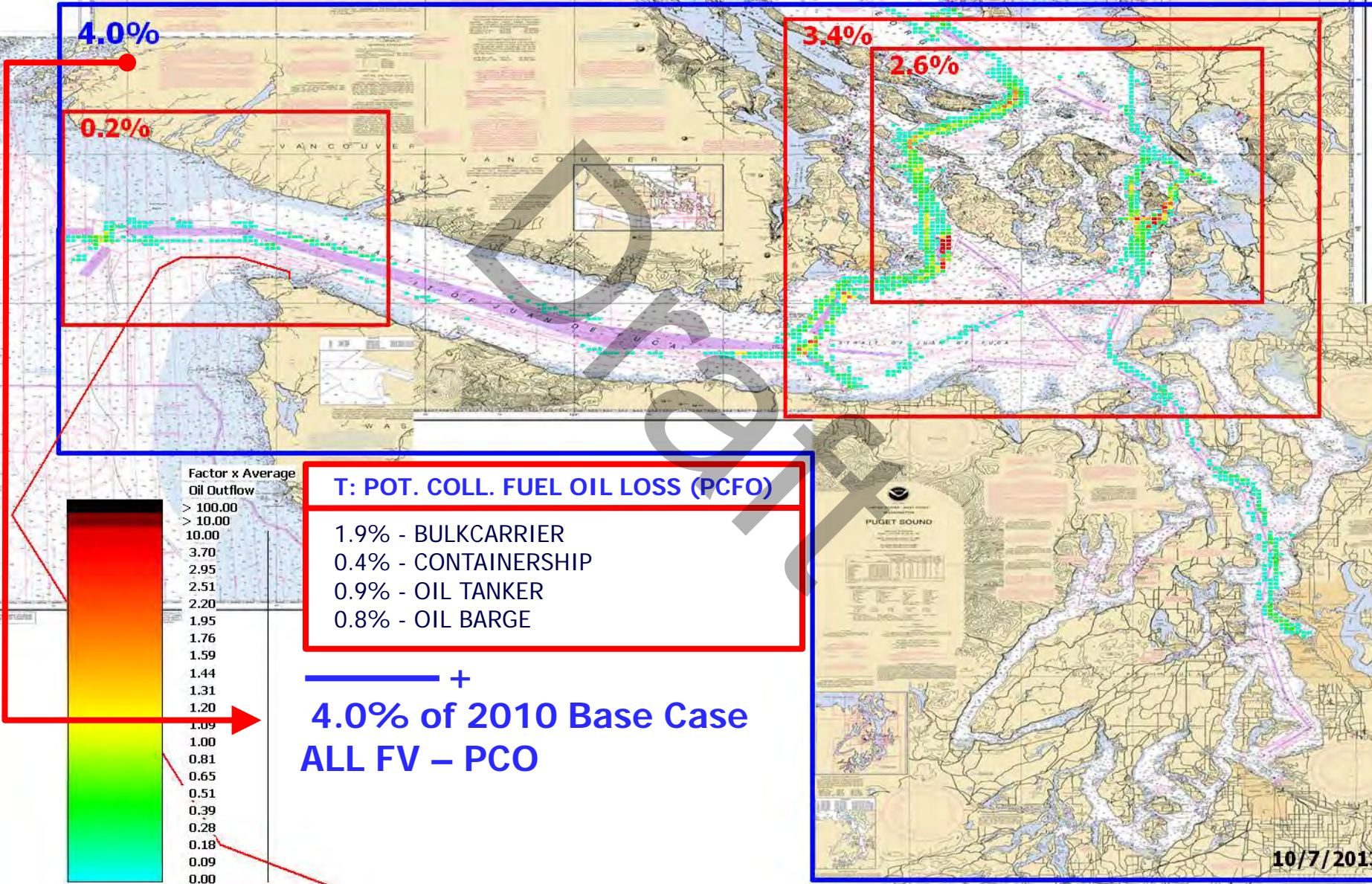
- T: POT. COLL. FUEL OIL LOSS (PCFO)**
- 2.3% - BULK CARGO
 - 2.8% - CONTAINERSHIP
 - 1.0% - OTHER CARGO
 - 4.9% - OIL BARGE
 - 2.0% - TANKER
 - 1.0% - CHEMICAL CARRIER
 - 0.2% - ATB
 - 4.0% - WHAT-IF FV

+
18.1% of 2010 Base Case
ALL FV - PFO



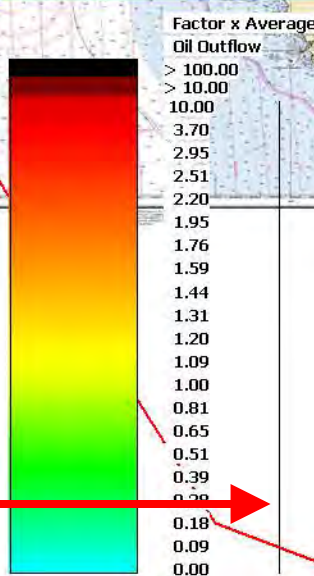
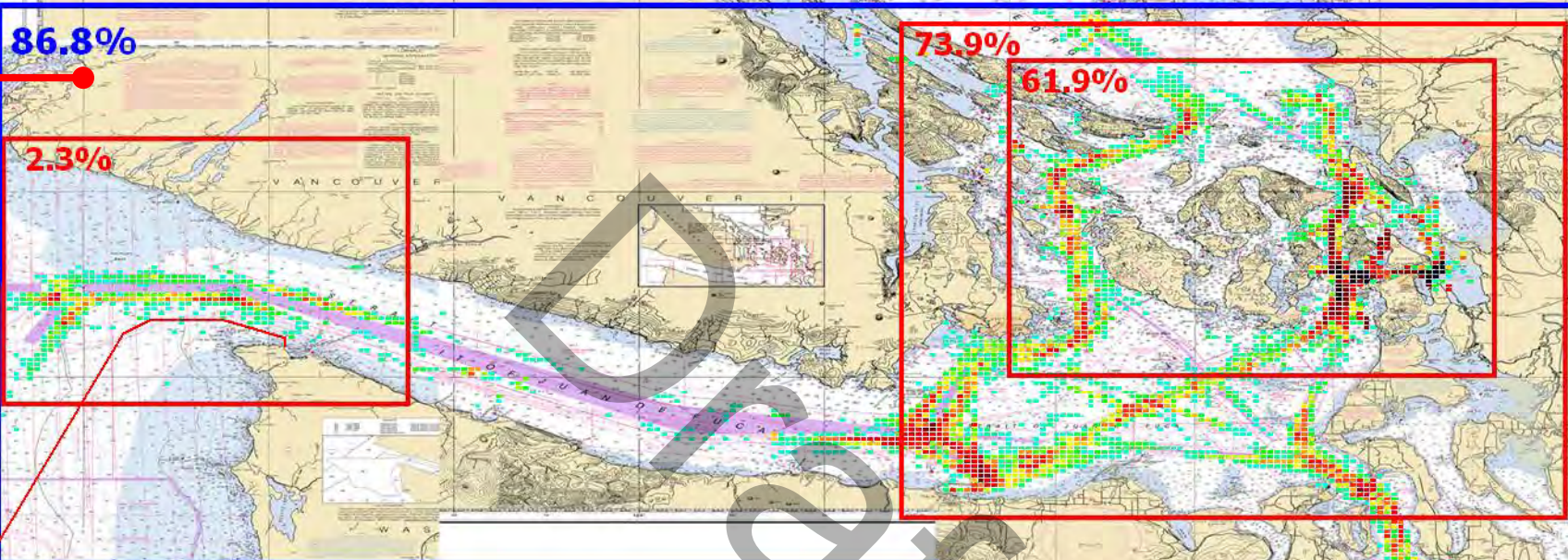
T: WHAT-IF FV POTENTIAL COLLISION FUEL OIL LOSS (PCFO)

T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348



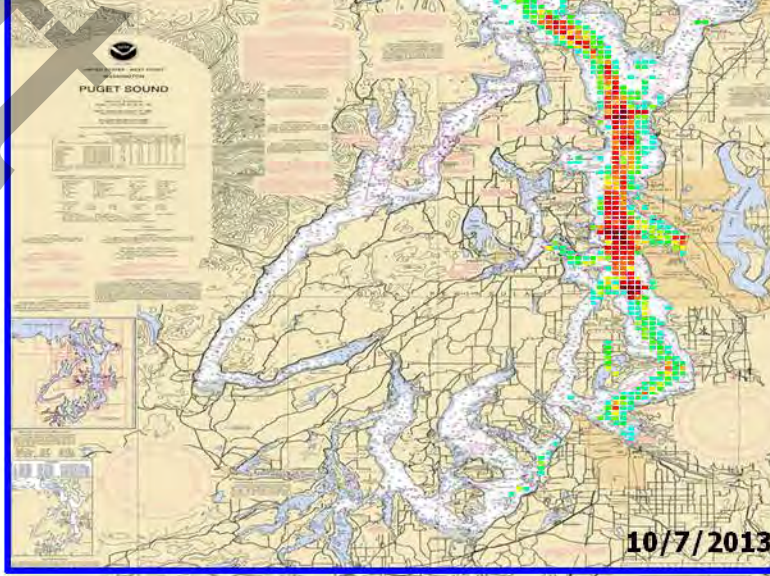
P: ALL FV POTENTIAL COLLISION CARGO OIL LOSS (PCCO)

P: VTRA 2010 - BASE CASE



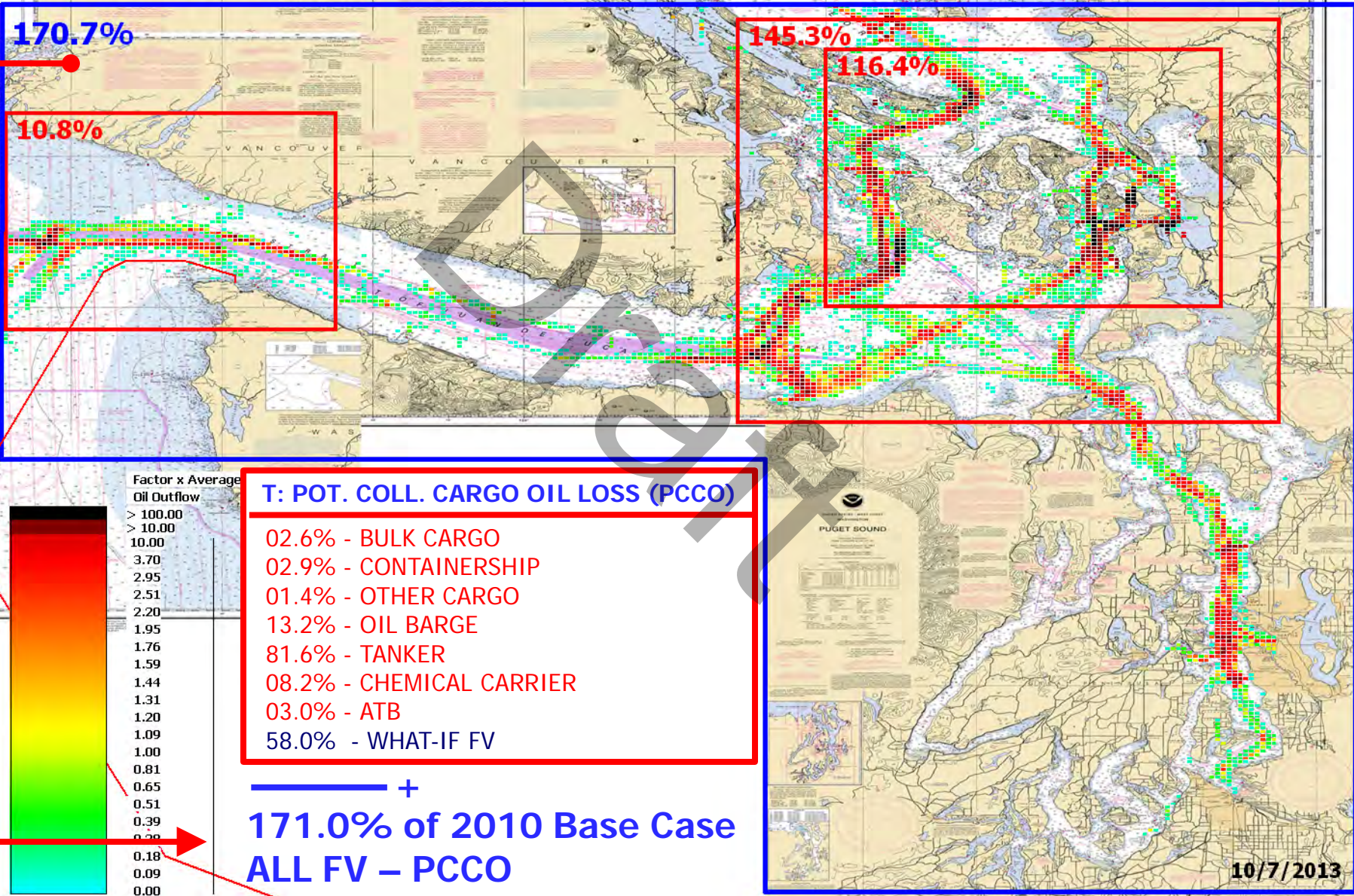
- P: POT. COLL. CARGO OIL LOSS (PCCO)**
- 00.9% - BULK CARGO
 - 01.5% - CONTAINERSHIP
 - 00.5% - OTHER CARGO
 - 16.3% - OIL BARGE
 - 52.9% - TANKER
 - 12.4% - CHEMICAL CARRIER
 - 02.3% - ATB
 - 00.0% - WHAT-IF FV

+ 86.8% of 2010 Base Case ALL FV - PCO



T: ALL FV POTENTIAL COLLISION CARGO OIL LOSS (PCCO)

T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348



170.7%

10.8%

145.3%

116.4%

T: POT. COLL. CARGO OIL LOSS (PCCO)

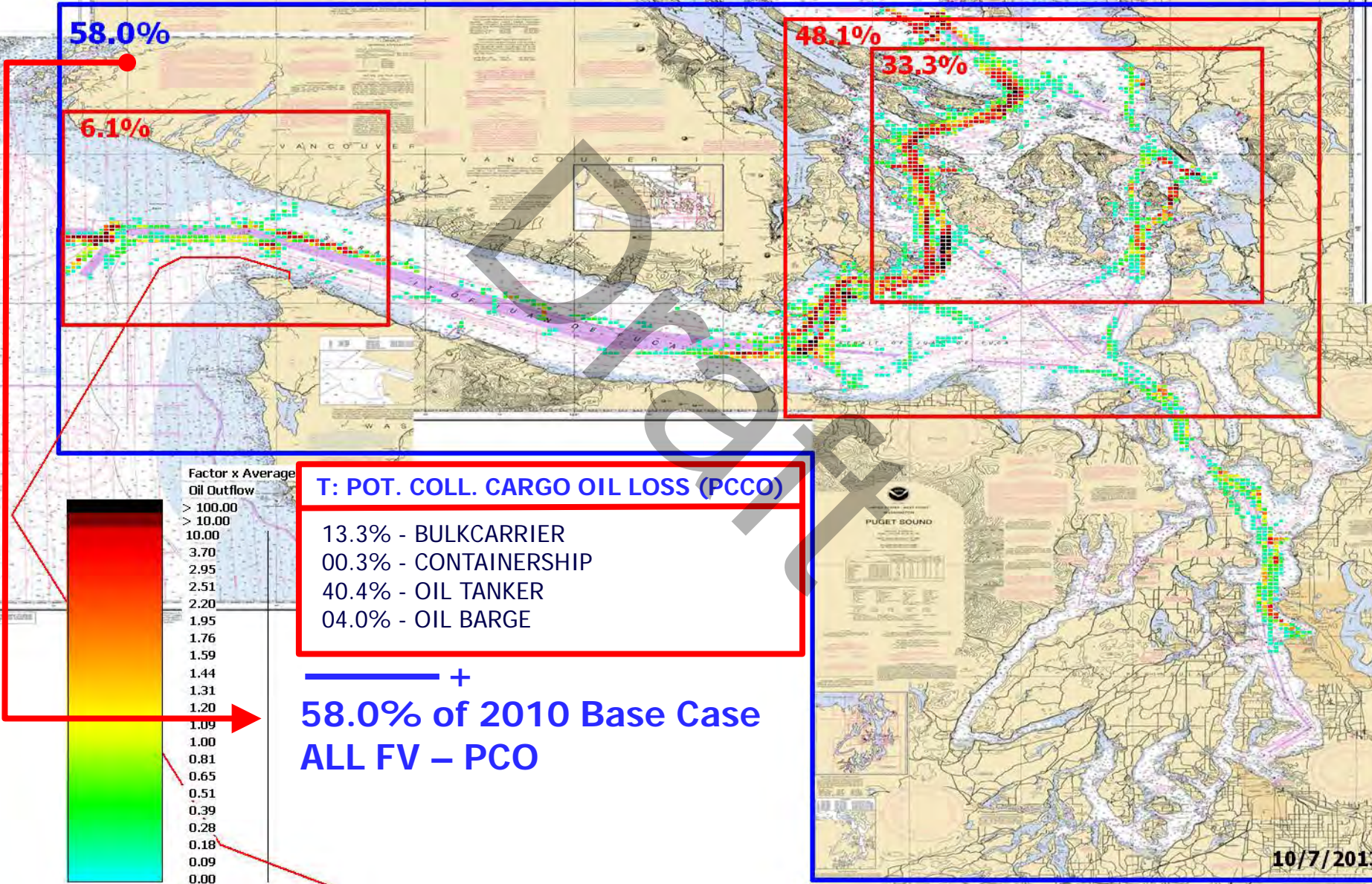
- 02.6% - BULK CARGO
- 02.9% - CONTAINERSHIP
- 01.4% - OTHER CARGO
- 13.2% - OIL BARGE
- 81.6% - TANKER
- 08.2% - CHEMICAL CARRIER
- 03.0% - ATB
- 58.0% - WHAT-IF FV

**+
171.0% of 2010 Base Case
ALL FV - PCCO**

Factor x Average Oil Outflow
> 100.00
> 10.00
10.00
3.70
2.95
2.51
2.20
1.95
1.76
1.59
1.44
1.31
1.20
1.09
1.00
0.81
0.65
0.51
0.39
0.28
0.18
0.09
0.00

T: WHAT-IF FV POTENTIAL COLLISION CARGO OIL LOSS (PCCO)

T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348



58.0%

6.1%

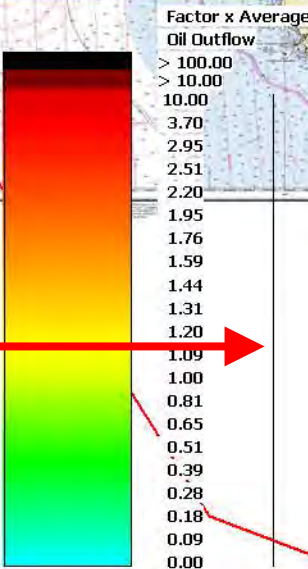
48.1%

33.3%

T: POT. COLL. CARGO OIL LOSS (PCCO)

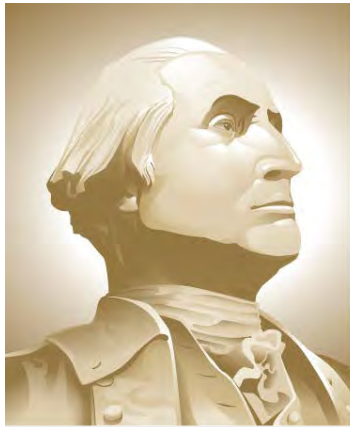
- 13.3% - BULKCARRIER
- 00.3% - CONTAINERSHIP
- 40.4% - OIL TANKER
- 04.0% - OIL BARGE

**58.0% of 2010 Base Case
ALL FV – PCO**



VTRA 2010 CASE T RESULTS – GROUNDING EXPOSURE AND ACCIDENT GEOGRAPHIC PROFILES

Presentation by: J. Rene van Dorp



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CASE T: Gateway, Kinder Morgan, Delta Port

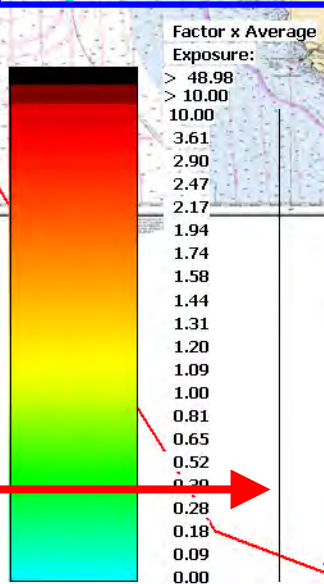
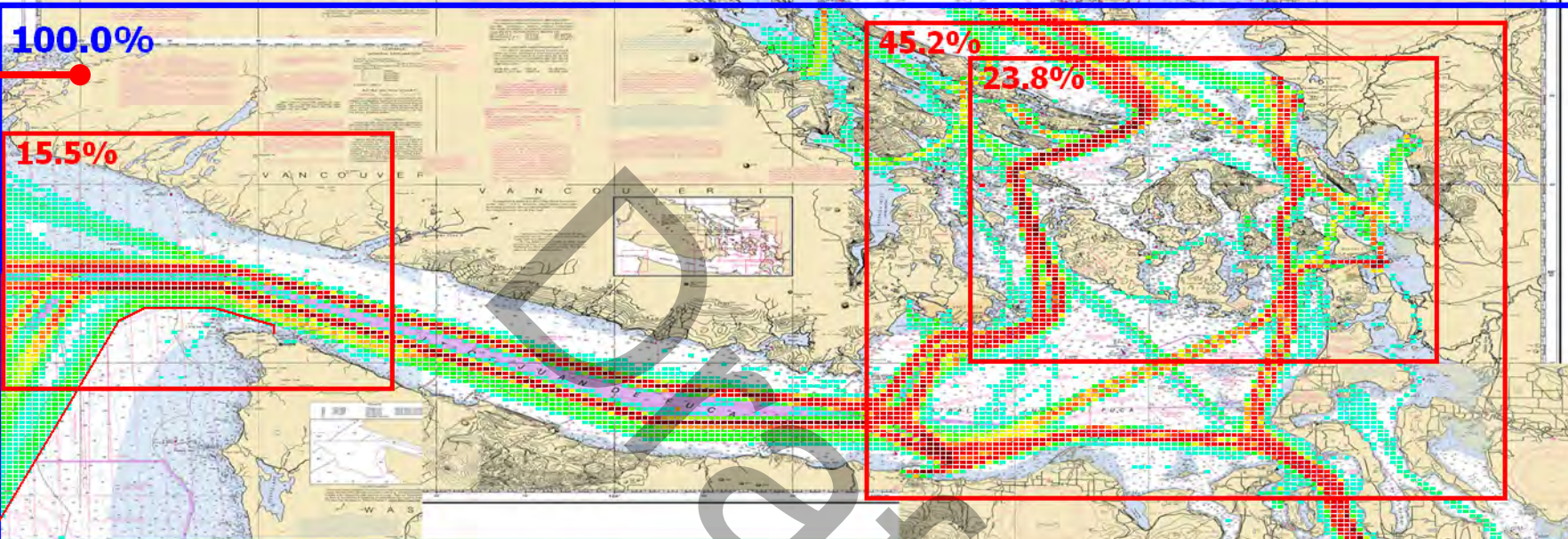
GWU Personnel: Dr. J. Rene van Dorp

VCU Personnel: Dr. Jason R. W. Merrick

OCTOBER 9, 2013

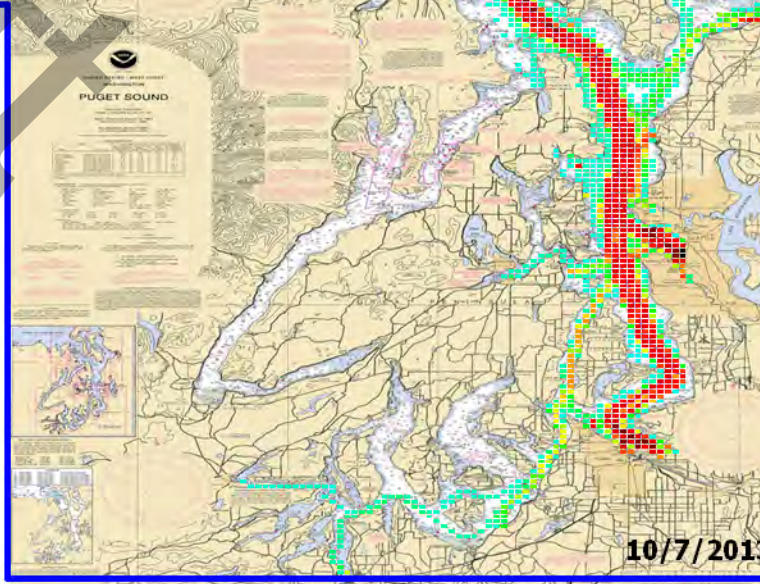
P: All FV TOTAL VESSEL TIME EXPOSURE (VTE)

P: VTRA 2010 - BASE CASE - All FV



- ### CASE P - ALL FV TRAFFIC DENSITY
- 32.6% - BULK CARGO
 - 20.2% - CONTAINERSHIP
 - 12.8% - OTHER CARGO
 - 19.3% - OIL BARGE
 - 08.8% - TANKER
 - 03.5% - CHEMICAL CARRIER
 - 02.7% - ATB
 - 00.0% - WHAT-IF FV

100.0% of 2010 Base Case
ALL FV - VTE



T: All FV TOTAL VESSEL TIME EXPOSURE (VTE)

T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348 - All FV

124.7%

19.9%

59.2%

33.5%

Factor x Average Exposure:

- > 48.98
- > 10.00
- 10.00
- 3.61
- 2.90
- 2.47
- 2.17
- 1.94
- 1.74
- 1.58
- 1.44
- 1.31
- 1.20
- 1.09
- 1.00
- 0.81
- 0.65
- 0.52
- 0.39
- 0.28
- 0.18
- 0.09
- 0.00

CASE T - ALL FV TRAFFIC DENSITY

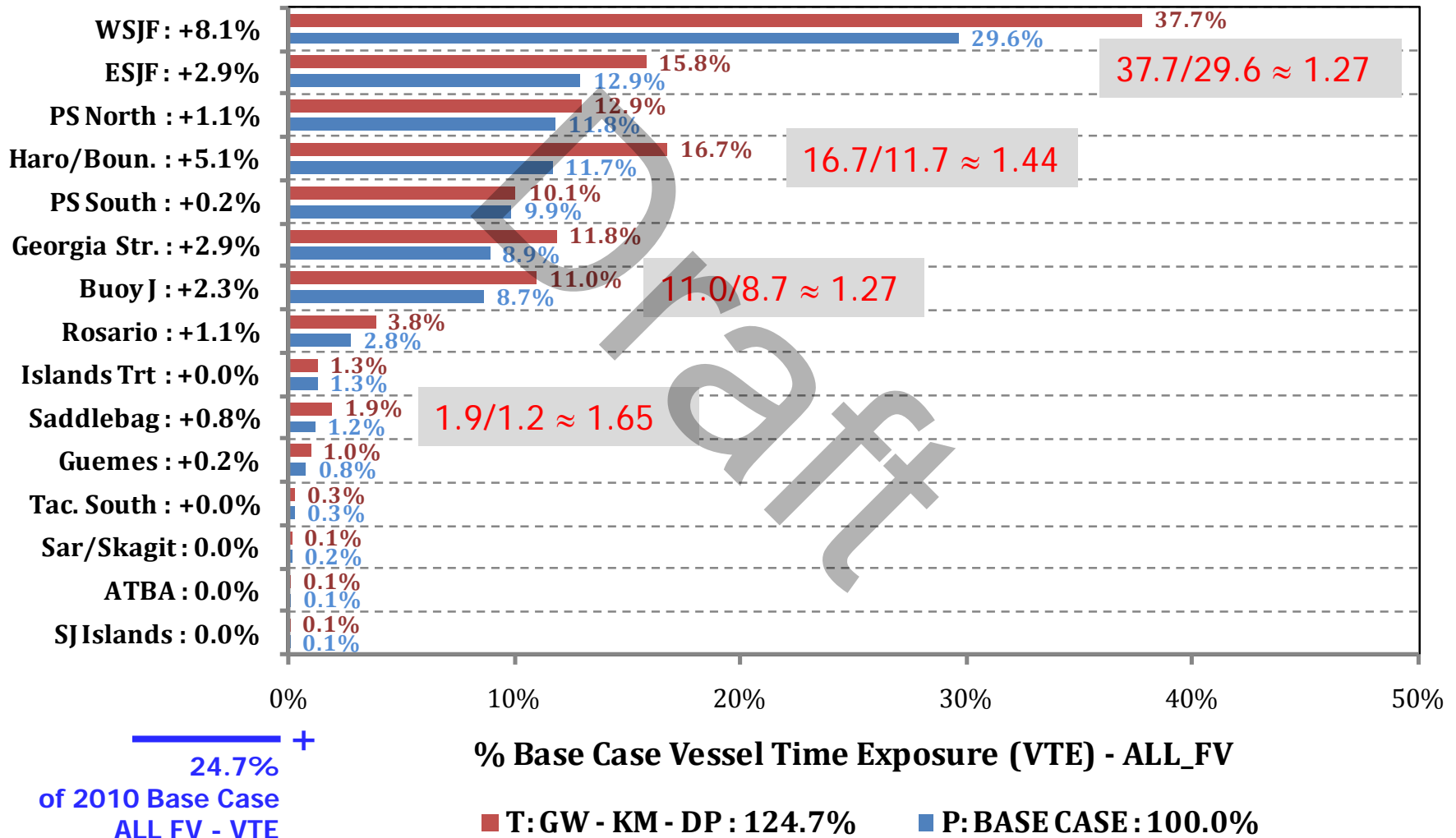
- 32.9% - BULK CARGO
- 20.4% - CONTAINERSHIP
- 12.9% - OTHER CARGO
- 19.1% - OIL BARGE
- 08.7% - TANKER
- 03.6% - CHEMICAL CARRIER
- 02.6% - ATB
- 24.4% - WHAT-IF FV

+
124.7% of 2010 Base Case
ALL FV - VTE

WATERWAY LOCATION

VESSEL TIME EXPOSURE ANALYSIS – ALL FOCUS VESSELS

% Base Case Vessel Time Exposure (VTE) - ALL_FV



T: WHAT-IF FV TOTAL VESSEL TIME EXPOSURE (VTE)

T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348

24.4%

4.5%

13.5%

9.2%

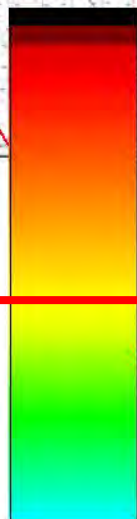
CASE T - ALL FV TRAFFIC DENSITY

- 12.5% - BULK CARGO
- 01.8% - CONTAINERSHIP
- 07.3% - TANKER
- 02.7% - OILBARGE

— +
24.4% of 2010 Base Case
ALL FV - VTE

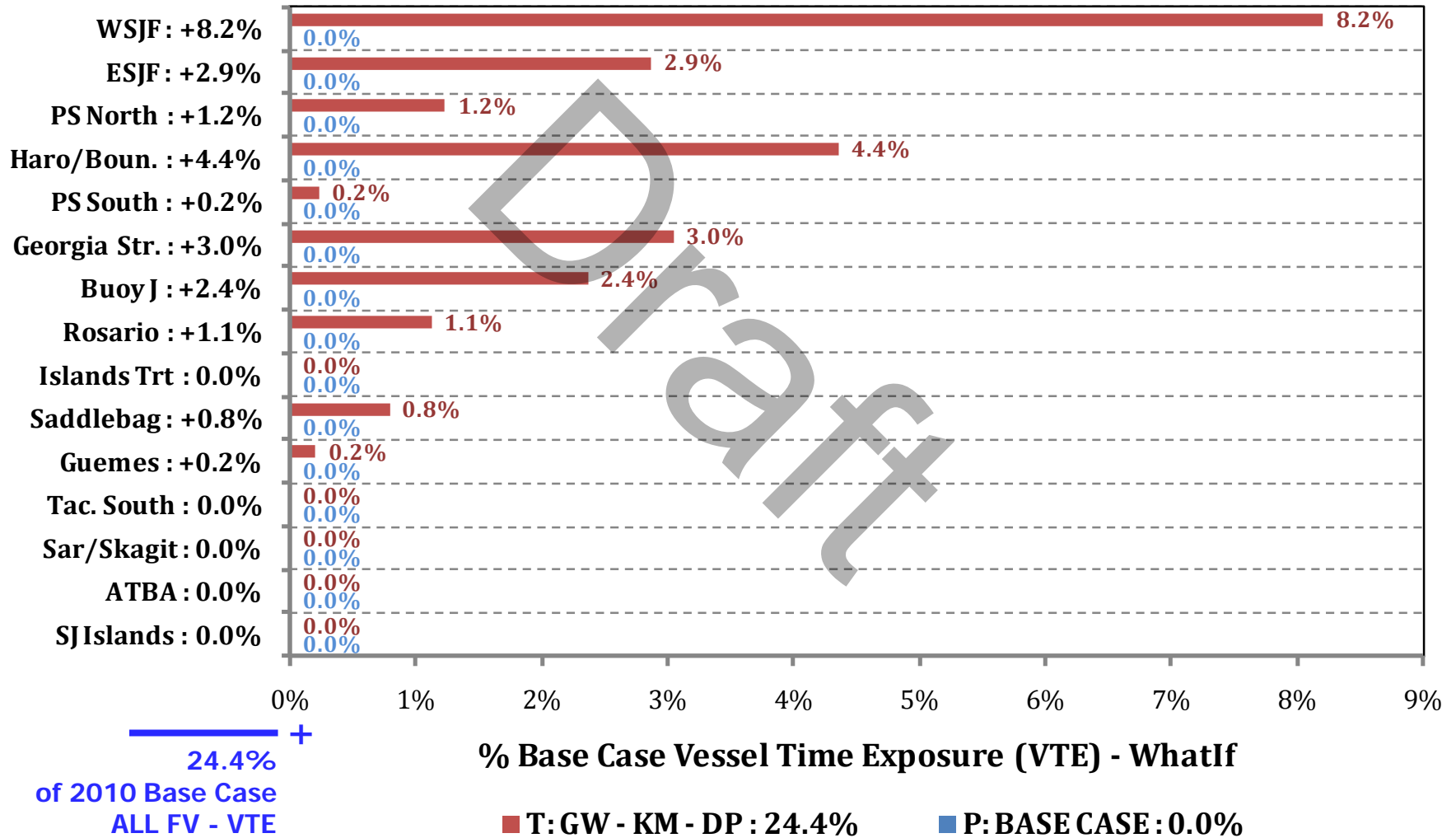
Factor x Average Exposure:

- > 48.98
- > 10.00
- 10.00
- 3.61
- 2.90
- 2.47
- 2.17
- 1.94
- 1.74
- 1.58
- 1.44
- 1.31
- 1.20
- 1.09
- 1.00
- 0.81
- 0.65
- 0.52
- 0.39
- 0.28
- 0.18
- 0.09
- 0.00



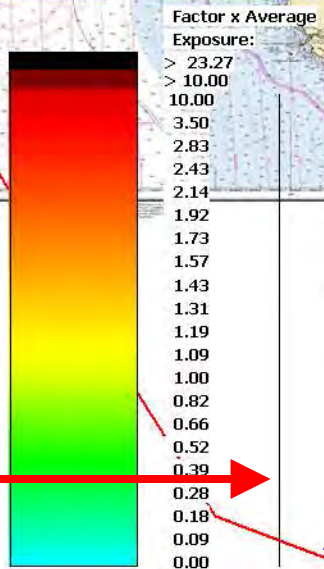
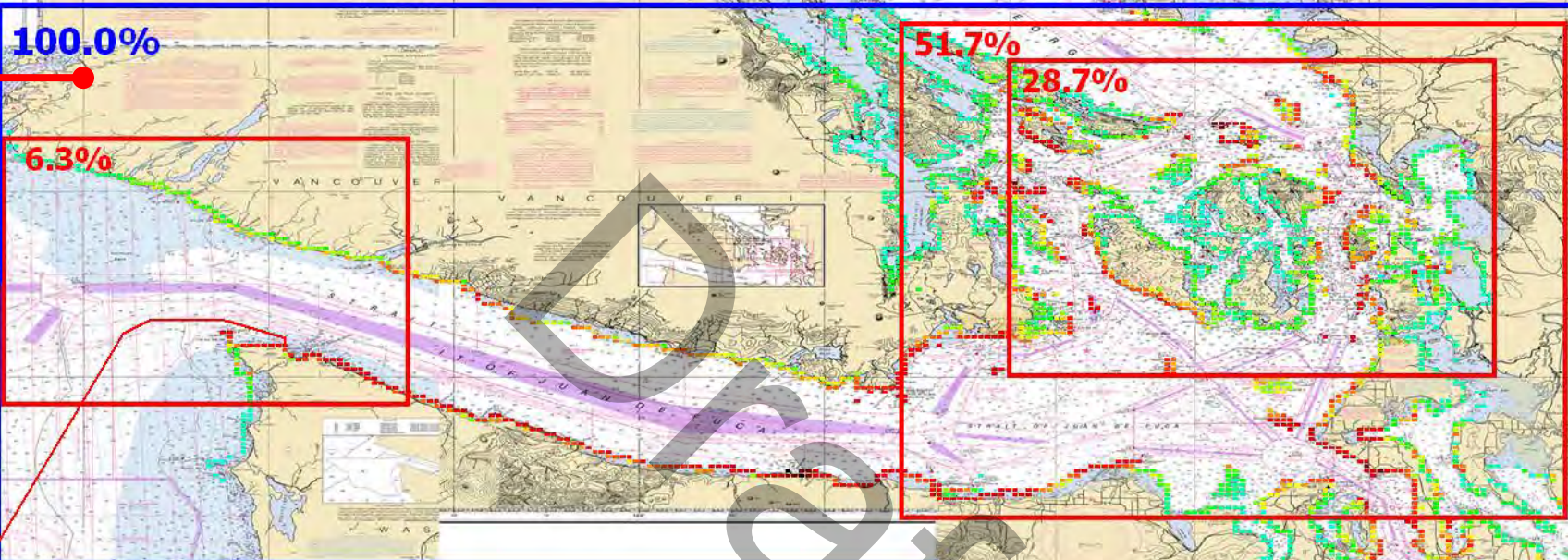
WATERWAY LOCATION VESSEL TIME EXPOSURE ANALYSIS – What If FV

% Base Case Vessel Time Exposure (VTE) - WhatIf



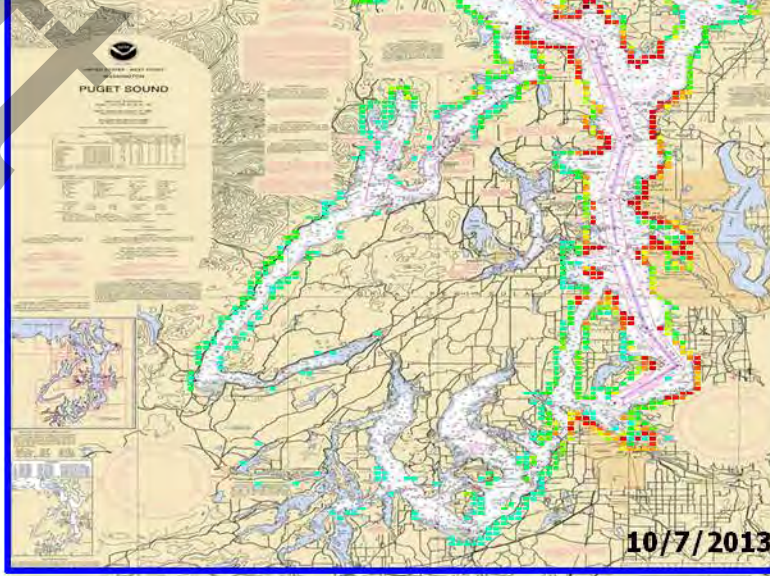
P: ALL FV POTENTIAL GROUNDING EXPOSURE (PGE)

P: VTRA 2010 - BASE CASE



- P: POT. GROUND. EXPOSURE (PGE)**
- 28.3% - BULK CARGO
 - 21.8% - CONTAINERSHIP
 - 12.9% - OTHERCARGO
 - 22.8% - OIL BARGE
 - 08.7% - TANKER
 - 03.2% - CHEMICAL CARRIER
 - 02.5% - ATB
 - 00.0% - WHAT-IF FV

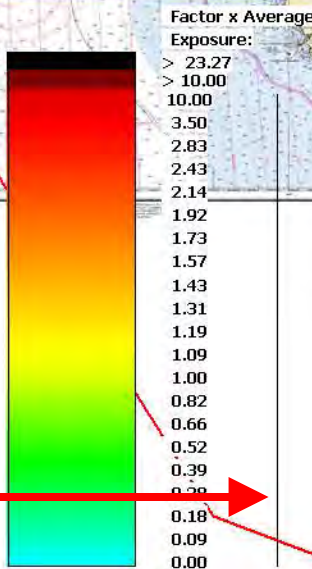
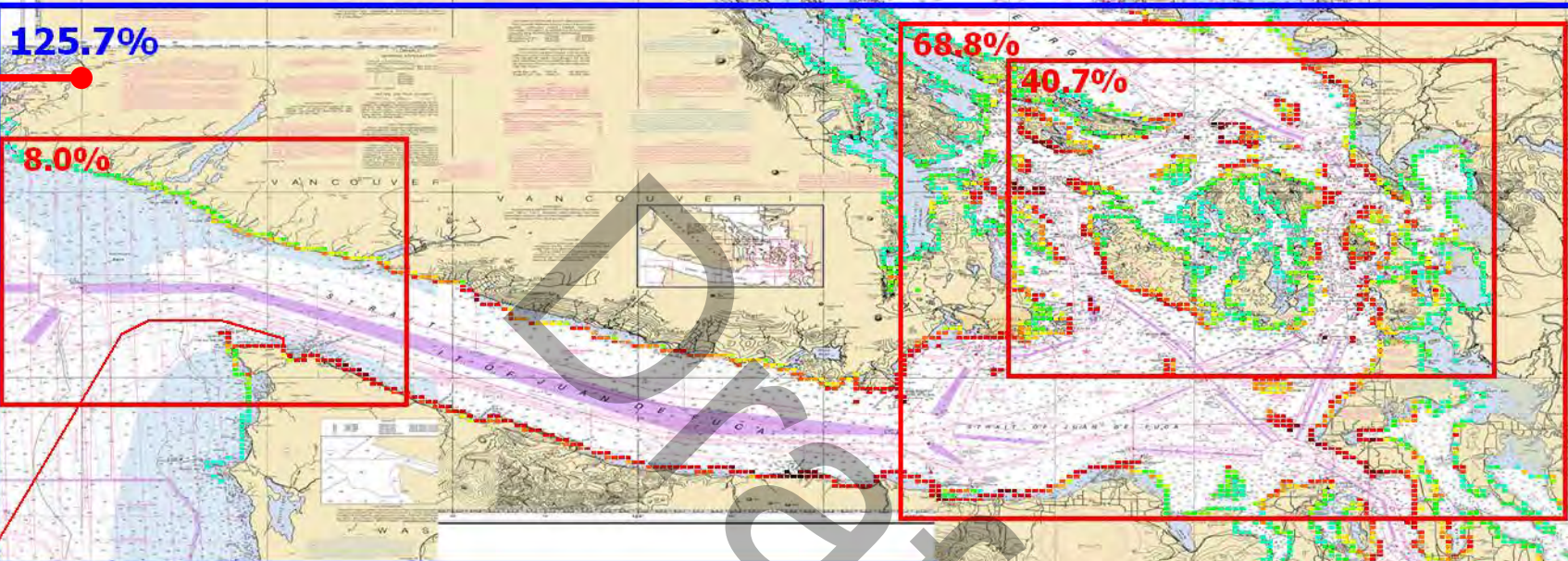
100.0% of 2010 Base Case ALL FV - PGE





T: ALL FV POTENTIAL GROUNDING EXPOSURE (PGE)

T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348

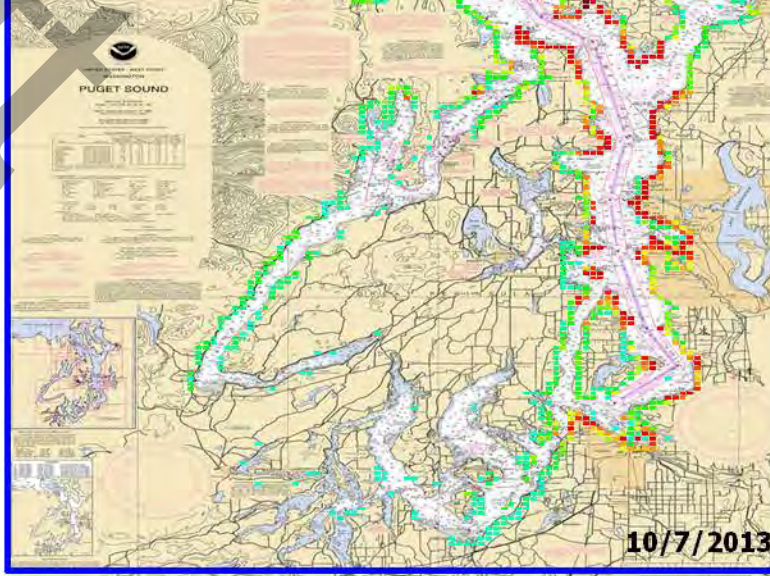


- ### T: POT. GROUND. EXPOSURE (PGE)
- 28.6% - BULK CARGO
 - 22.0% - CONTAINERSHIP
 - 13.0% - OTHERCARGO
 - 22.4% - OIL BARGE
 - 08.6% - TANKER
 - 03.2% - CHEMICAL CARRIER
 - 02.5% - ATB
 - 25.4% - WHAT-IF FV

— +

125.7% of 2010 Base Case

ALL FV - PGE



T: WHAT-IF FV POTENTIAL GROUNDING EXPOSURE (PGE)



T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348

25.4%

1.7%

16.6%

11.5%

Factor x Average
Exposure:

- > 23.27
- > 10.00
- 10.00
- 3.50
- 2.83
- 2.43
- 2.14
- 1.92
- 1.73
- 1.57
- 1.43
- 1.31
- 1.19
- 1.09
- 1.00
- 0.82
- 0.66
- 0.52
- 0.39
- 0.28
- 0.18
- 0.09
- 0.00

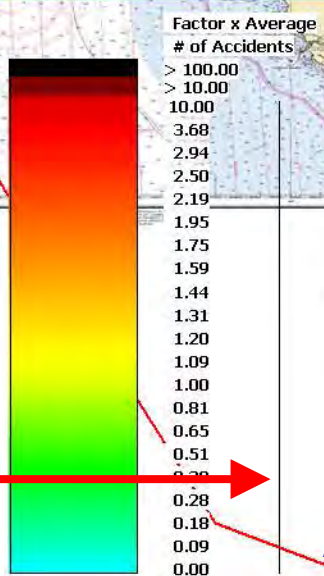
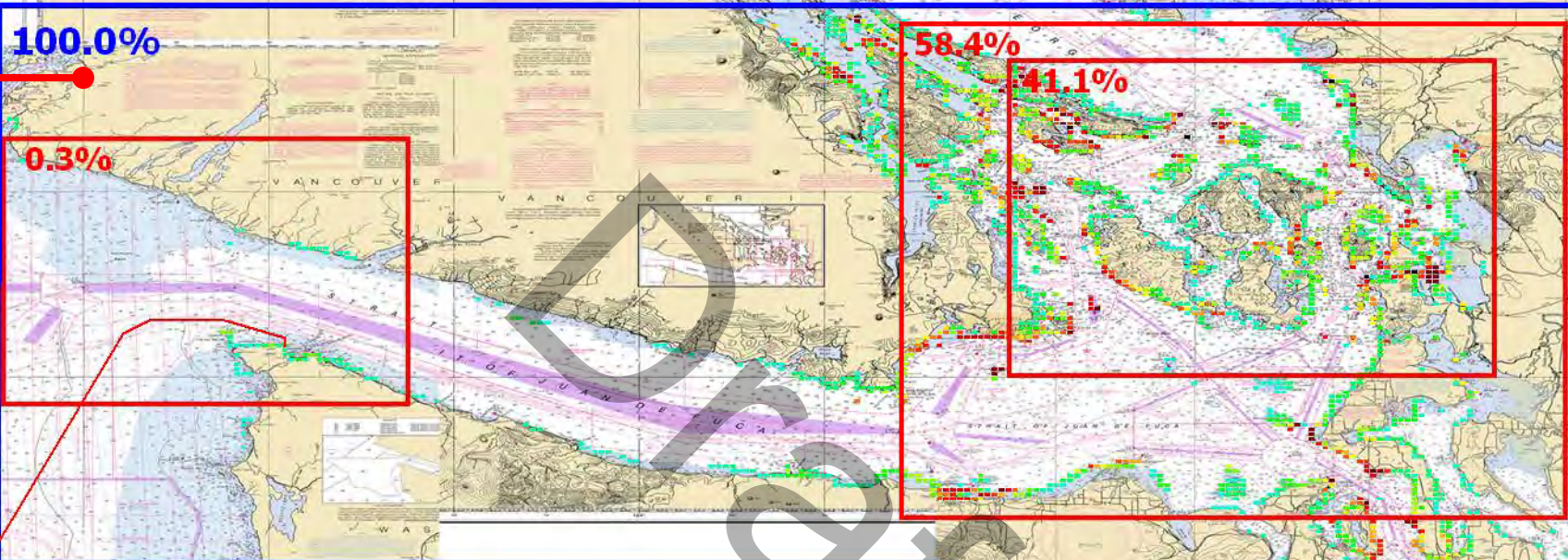
T: POT. GROUND. EXPOSURE (PGE)

- 12.6% - BULK CARGO
- 01.8% - CONTAINERSHIP
- 07.1% - TANKER
- 03.9% - OILBARGE

— +
25.4% of 2010 Base Case
ALL FV - PGE

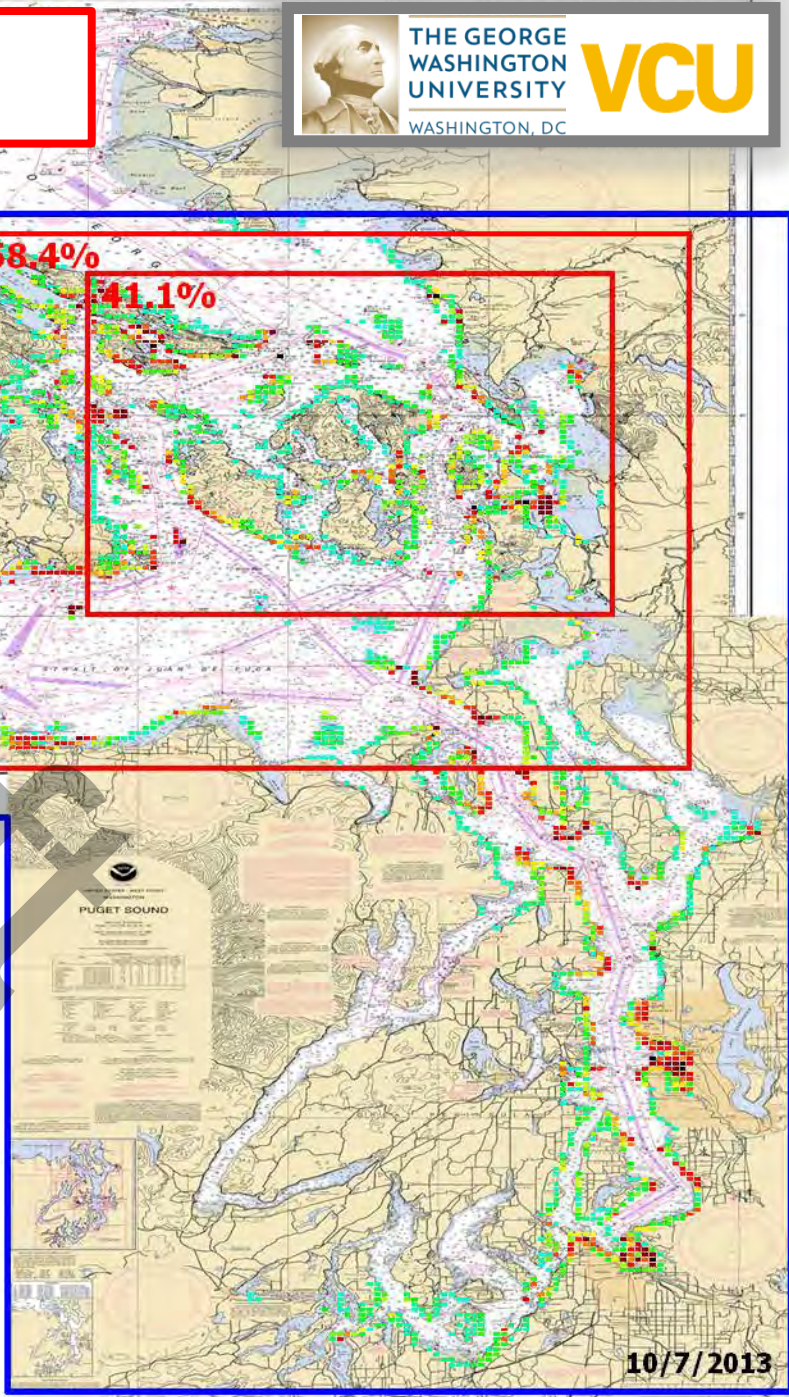
**P: ALL FV POTENTIAL
GROUNDING FREQUENCY (PGF)**

P: VTRA 2010 - BASE CASE



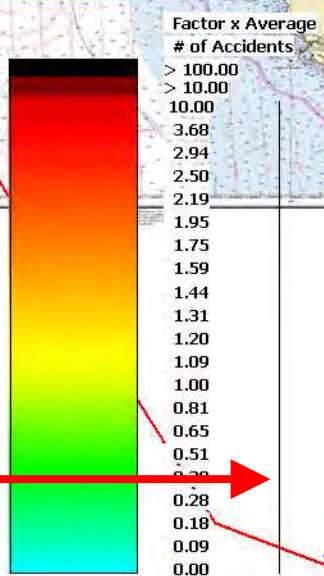
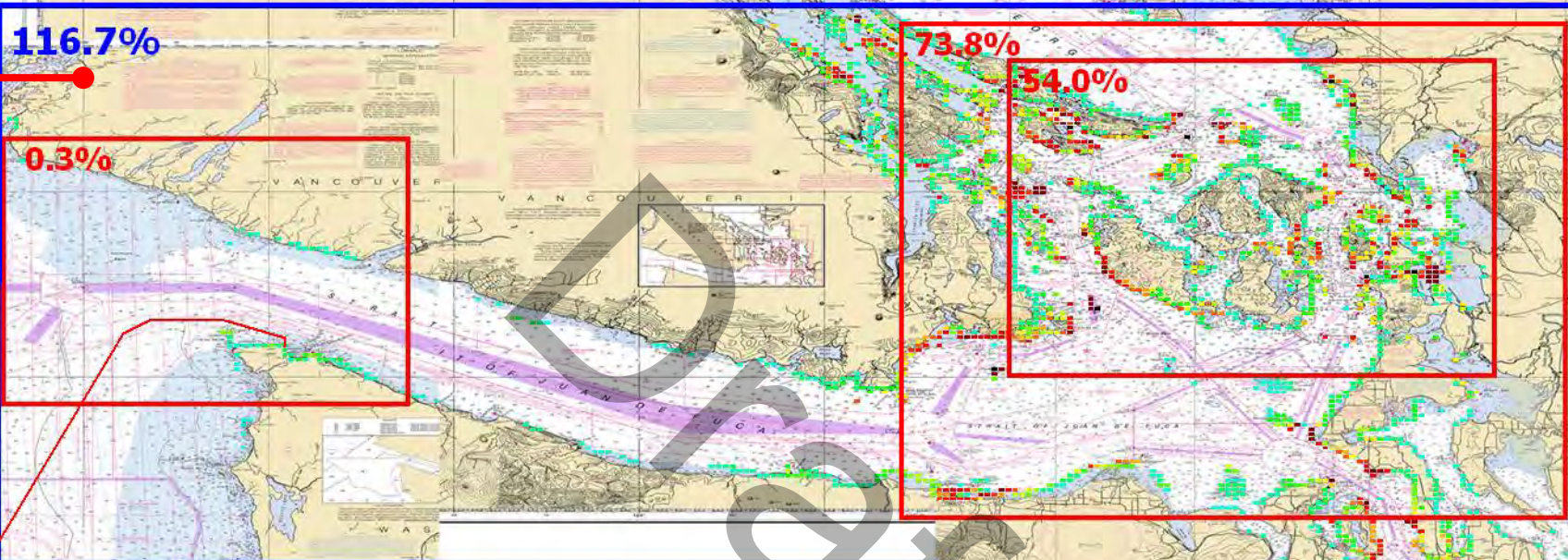
- P: POTENTIAL GROUND. FREQ. (PGF)**
- 22.0% - BULK CARGO
 - 22.8% - CONTAINERSHIP
 - 14.4% - OTHERCARGO
 - 24.3% - OIL BARGE
 - 11.4% - TANKER
 - 03.0% - CHEMICAL CARRIER
 - 02.1% - ATB
 - 00.0% - WHAT-IF FV

**100.0% of 2010 Base Case
ALL FV - PGF**



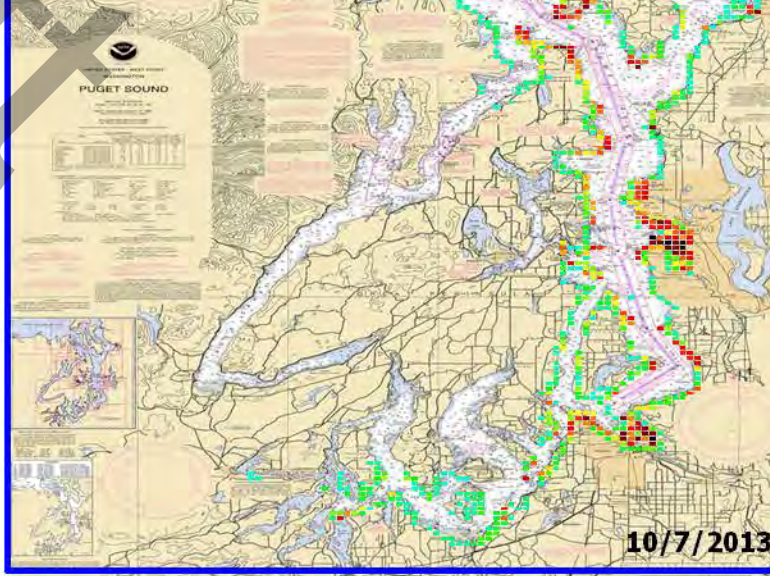
**T: ALL FV POTENTIAL
GROUNDING FREQUENCY (PGF)**

T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348



- T: POTENTIAL GROUND. FREQ. (PGF)**
- 21.9% - BULK CARGO
 - 22.6% - CONTAINERSHIP
 - 14.3% - OTHERCARGO
 - 22.4% - OIL BARGE
 - 11.3% - TANKER
 - 03.0% - CHEMICAL CARRIER
 - 02.1% - ATB
 - 19.0% - WHAT-IF FV

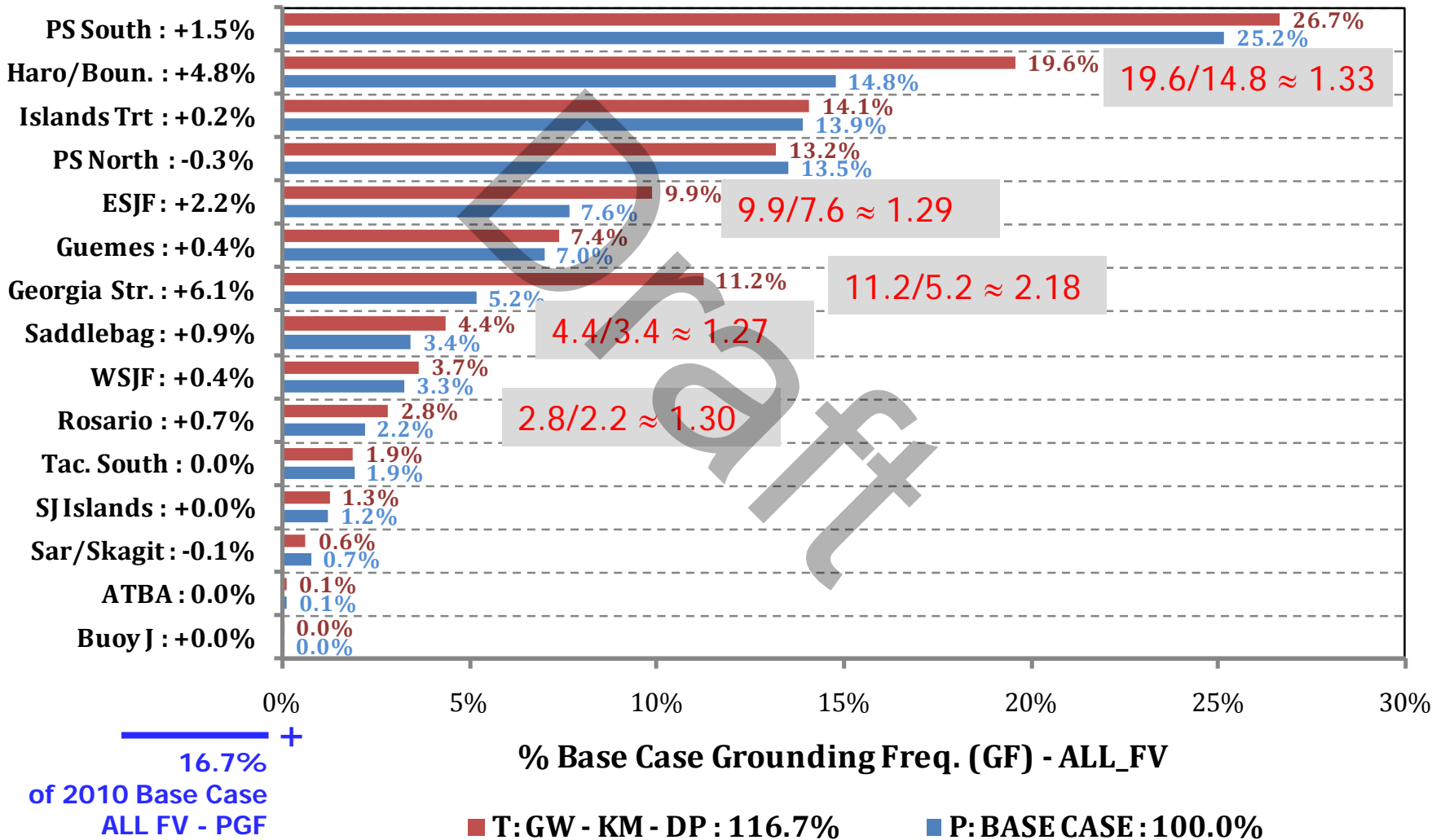
**116.7% of 2010 Base Case
ALL FV - PGF**



WATERWAY LOCATION

Potential Grounding Freq. Comparison – ALL FV

% Base Case Grounding Frequency - ALL_FV



T: WHAT-IF FV POTENTIAL GROUNDING FREQUENCY (PGF)



T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348

19.0%

0.0%

17.0%

14.3%

Factor x Average
of Accidents

- > 100.00
- > 10.00
- 10.00
- 3.68
- 2.94
- 2.50
- 2.19
- 1.95
- 1.75
- 1.59
- 1.44
- 1.31
- 1.20
- 1.09
- 1.00
- 0.81
- 0.65
- 0.51
- 0.39
- 0.28
- 0.18
- 0.09
- 0.00

T: POTENTIAL GROUND. FREQ. (PGF)

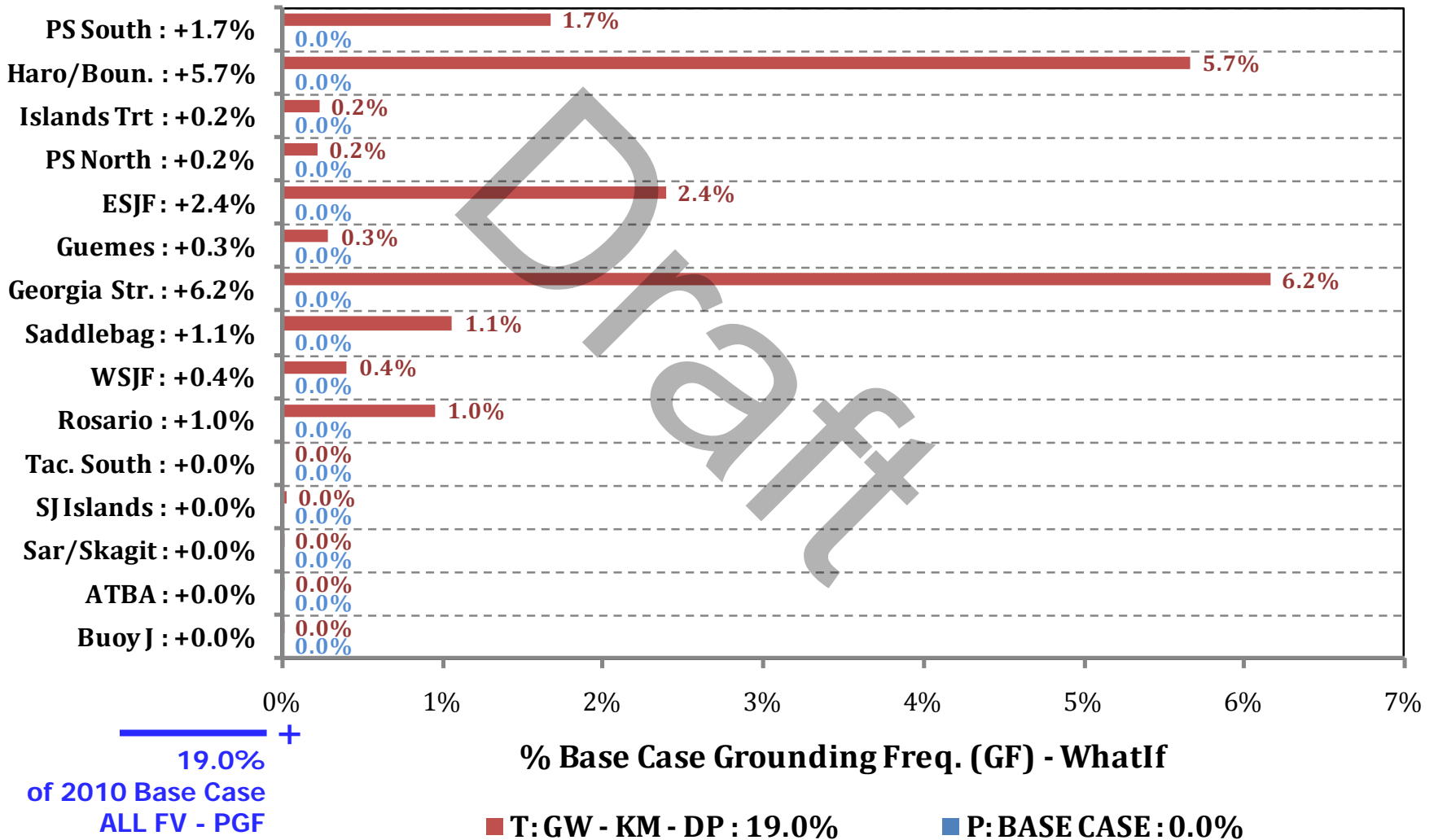
- 09.3% - BULK CARGO
- 01.9% - CONTAINERSHIP
- 04.2% - TANKER
- 03.6% - OILBARGE

— +
19.0% of 2010 Base Case
ALL FV - PGF

WATERWAY LOCATION

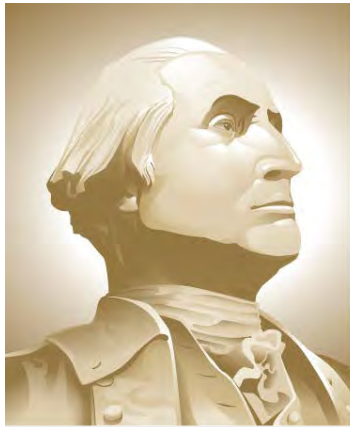
Potential Grounding Freq. Comparison – WHAT-IF FV

% Base Case Grounding Frequency - WhatIf



VTRA 2010 CASE T RESULTS – GROUNDING OIL LOSS (CARGO + FUEL), GEOGRAPHIC PROFILES

Presentation by: J. Rene van Dorp



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UNIVERSITY

WASHINGTON, DC

VCU

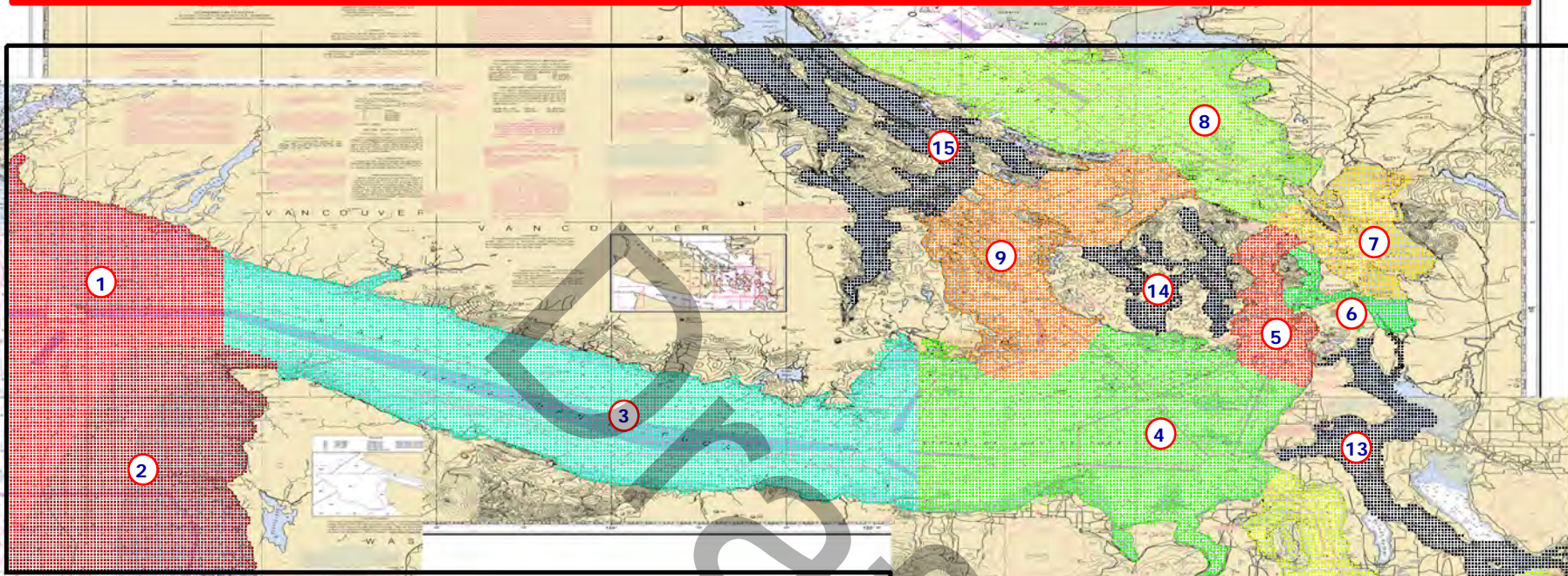
CASE T: Gateway, Kinder Morgan, Delta Port

GWU Personnel: Dr. J. Rene van Dorp

VCU Personnel: Dr. Jason R. W. Merrick

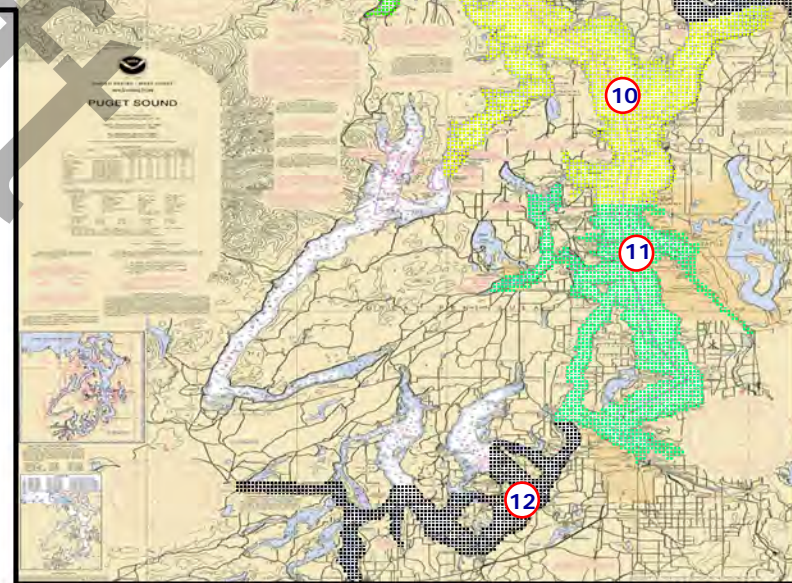
OCTOBER 9, 2013

DEFINITION OF 15 WATERWAY LOCATIONS



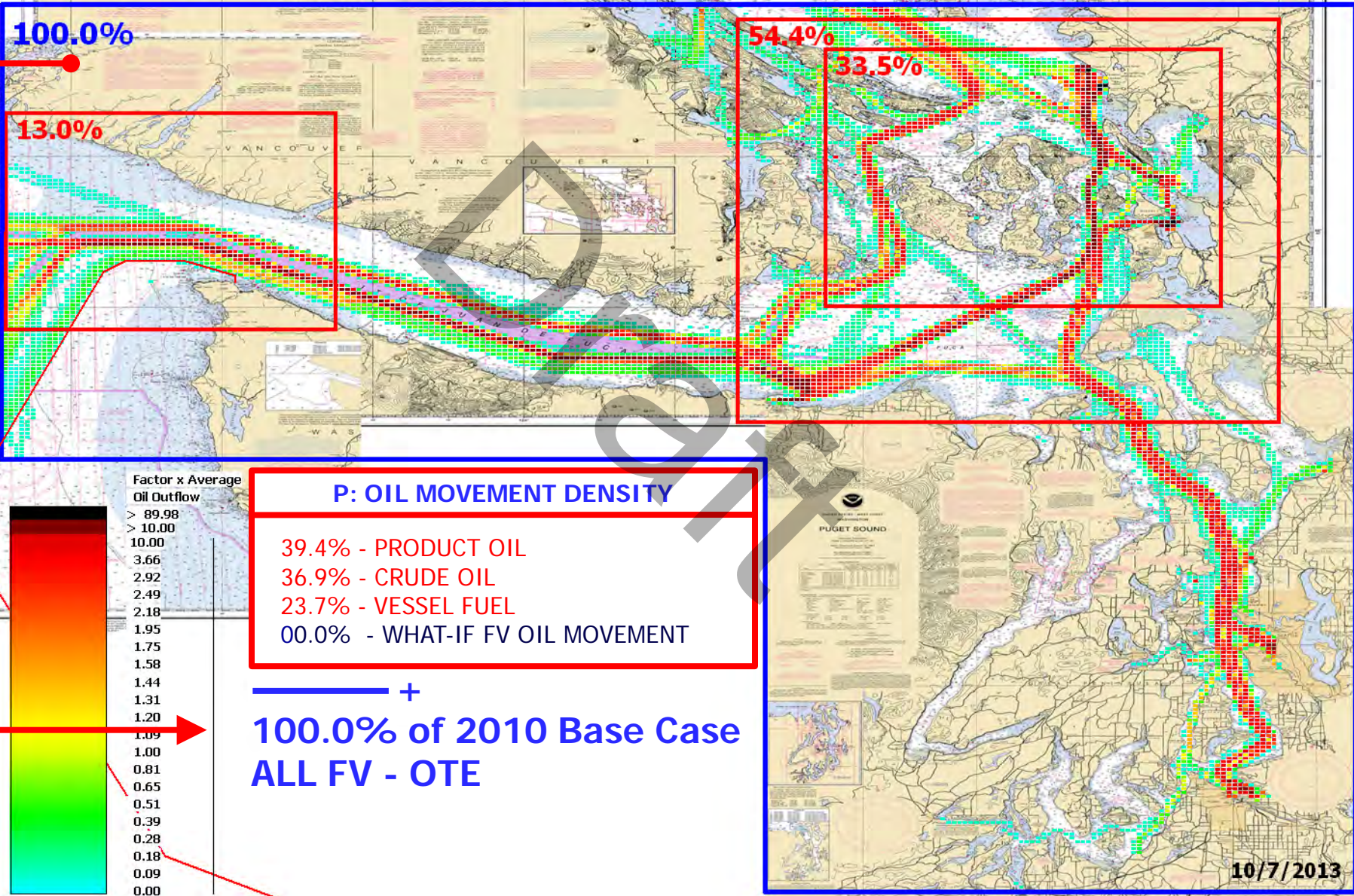
VTRA 2010 Waterway Locations

- | | |
|-----------------|-----------------|
| 1. Buoy J | 9. Harp/Boun. |
| 2. ATBA | 10. PS North |
| 3. WSJF | 11. PS South |
| 4. ESJF | 12. Tacoma |
| 5. Rosario | 13. Sar/Skagit |
| 6. Guemes | 14. SJ Islands |
| 7. Saddlebag | 15. Islands Trt |
| 8. Georgia Str. | |



P: ALL FV ALL OIL MOVEMENT

P: VTRA 2010 - BASE CASE - All FV



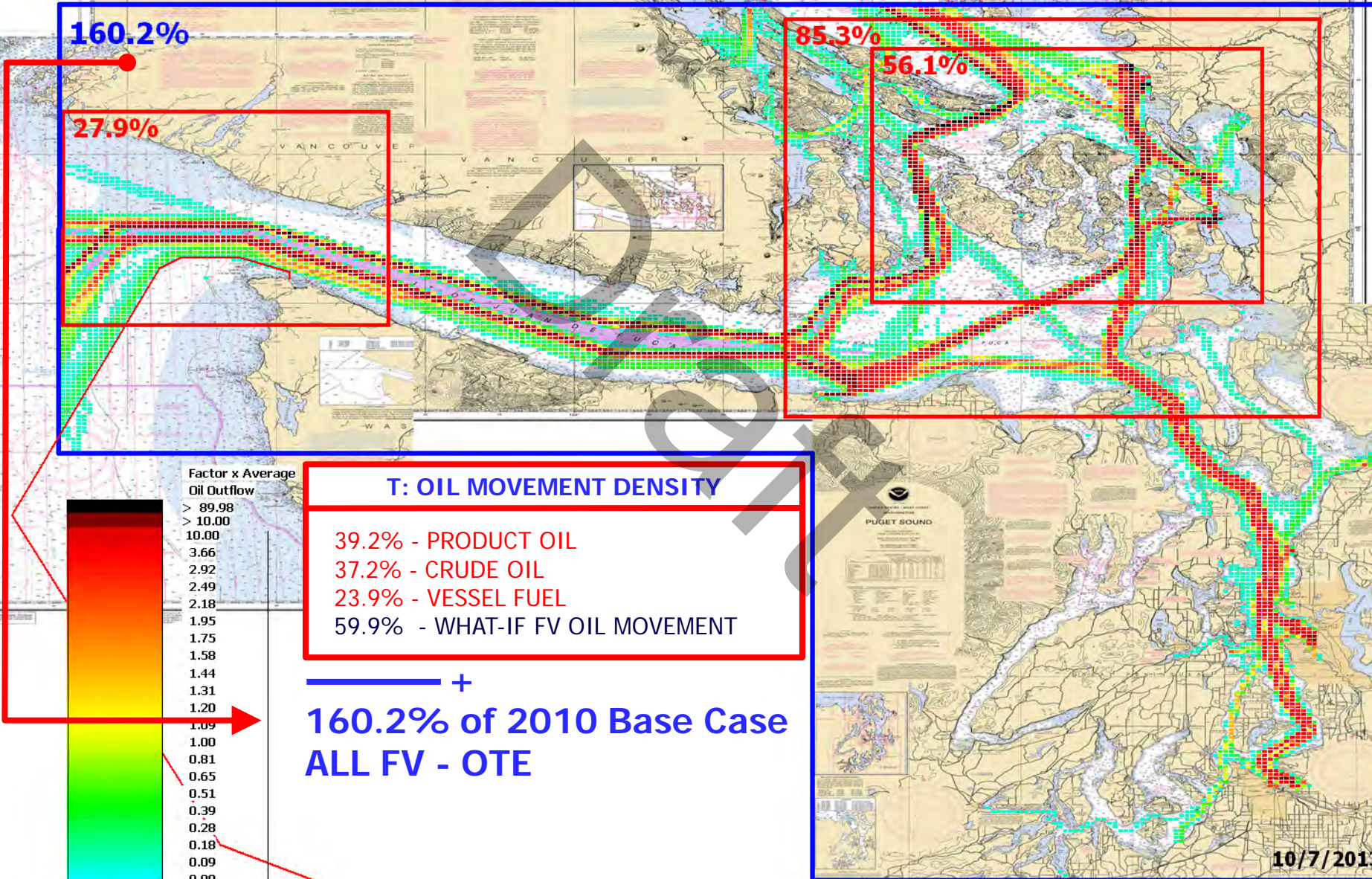
P: OIL MOVEMENT DENSITY

- 39.4% - PRODUCT OIL
- 36.9% - CRUDE OIL
- 23.7% - VESSEL FUEL
- 00.0% - WHAT-IF FV OIL MOVEMENT

+
**100.0% of 2010 Base Case
ALL FV - OTE**

T: ALL FV ALL OIL MOVEMENT

T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348 - All FV



160.2%

27.9%

85.3%

56.1%

T: OIL MOVEMENT DENSITY

- 39.2% - PRODUCT OIL
- 37.2% - CRUDE OIL
- 23.9% - VESSEL FUEL
- 59.9% - WHAT-IF FV OIL MOVEMENT

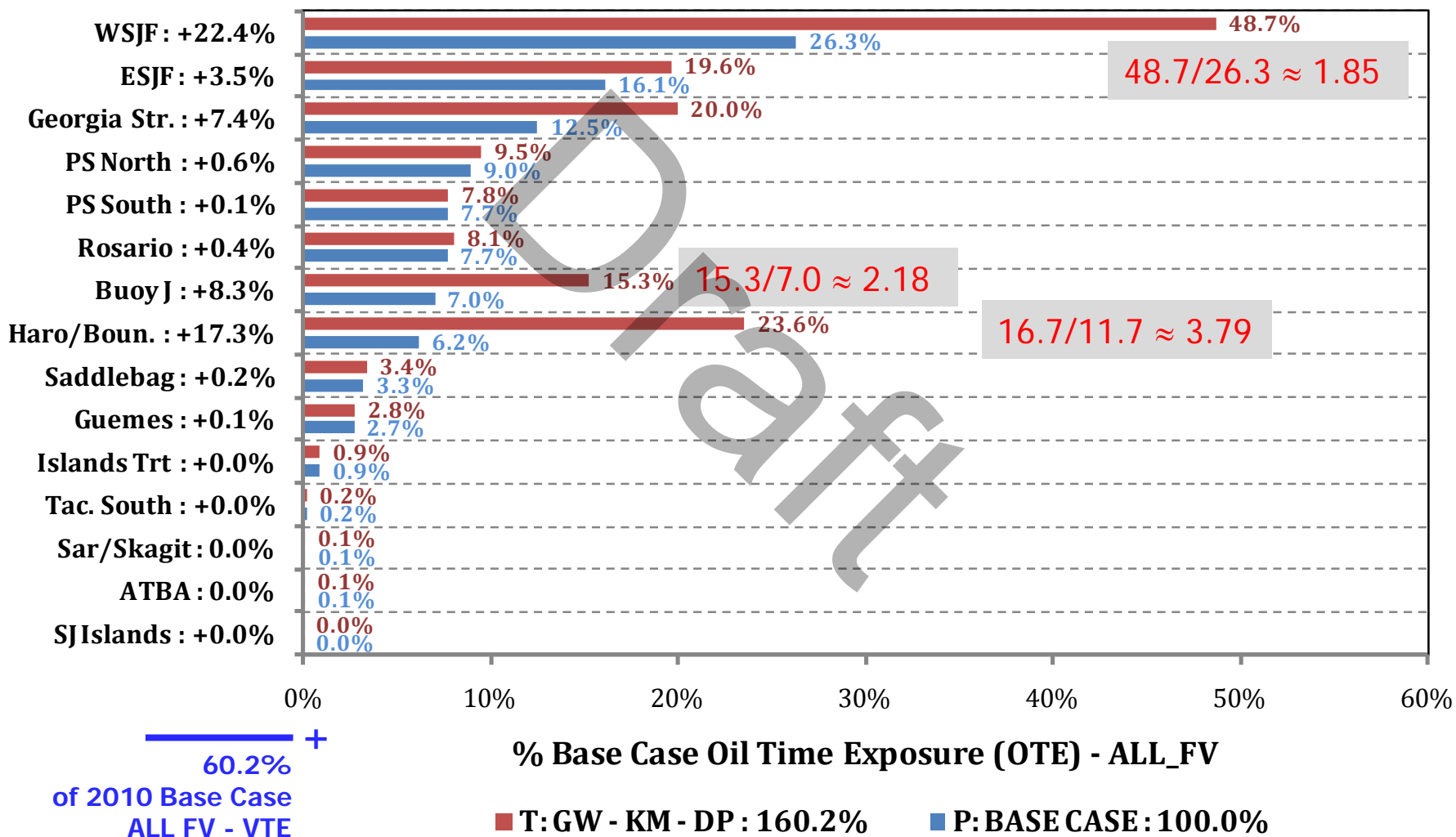
— +
160.2% of 2010 Base Case
ALL FV - OTE

Factor x Average Oil Outflow

> 89.98
> 10.00
10.00
3.66
2.92
2.49
2.18
1.95
1.75
1.58
1.44
1.31
1.20
1.09
1.00
0.81
0.65
0.51
0.39
0.28
0.18
0.09
0.00

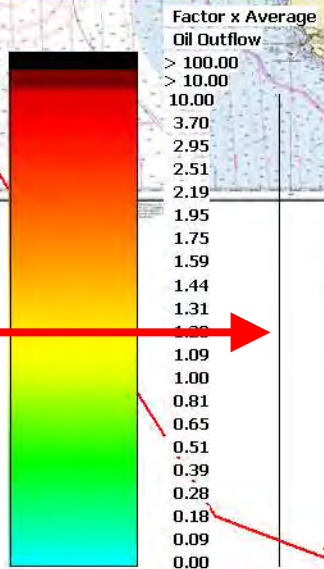
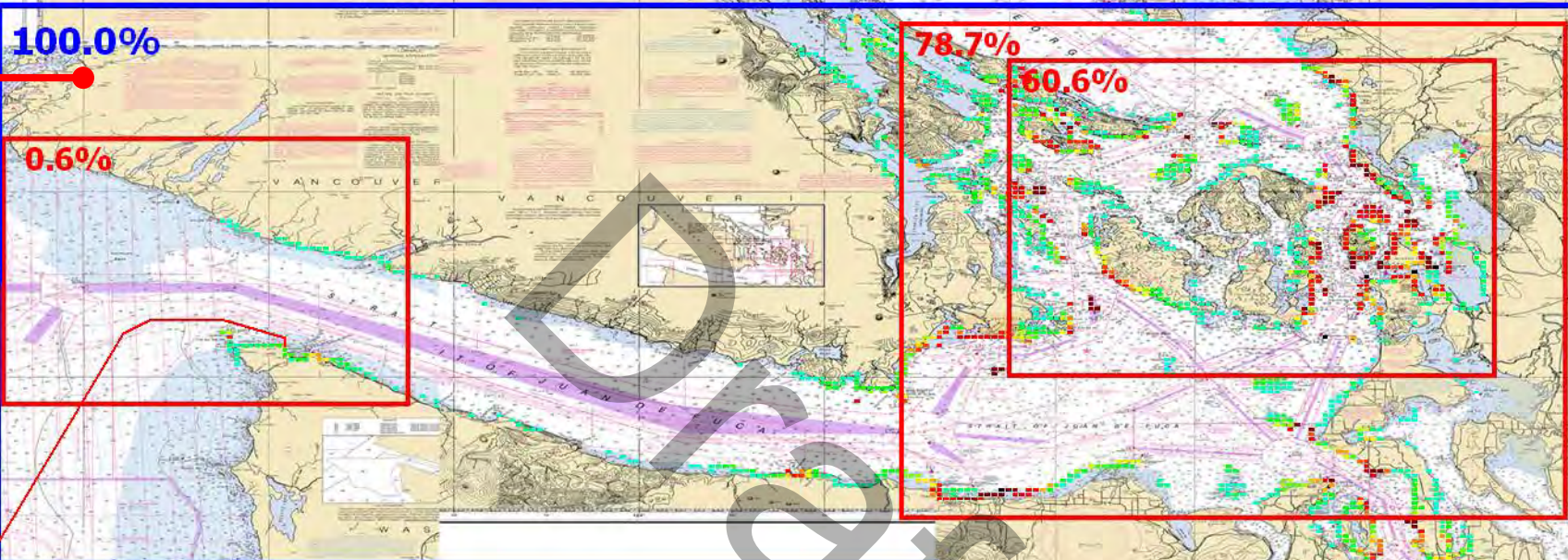
WATERWAY LOCATION OIL TIME EXPOSURE COMPARISON (P+C+F)

% Base Case Oil Time Exposure - ALL_FV



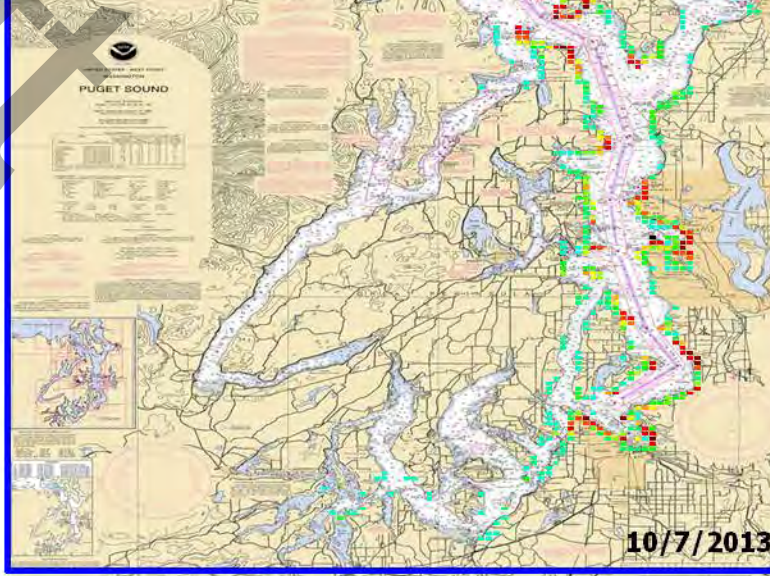
**P: ALL FV POTENTIAL
GROUNDING OIL (FUEL + CARGO) LOSS (PGO)**

P: VTRA 2010 - BASE CASE



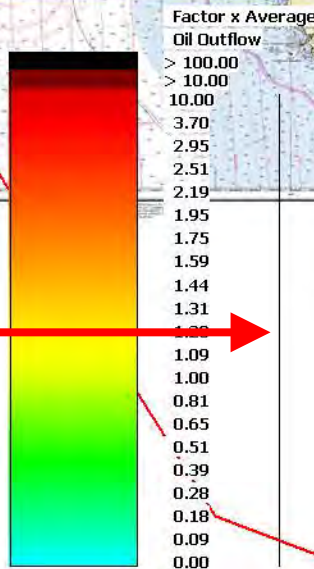
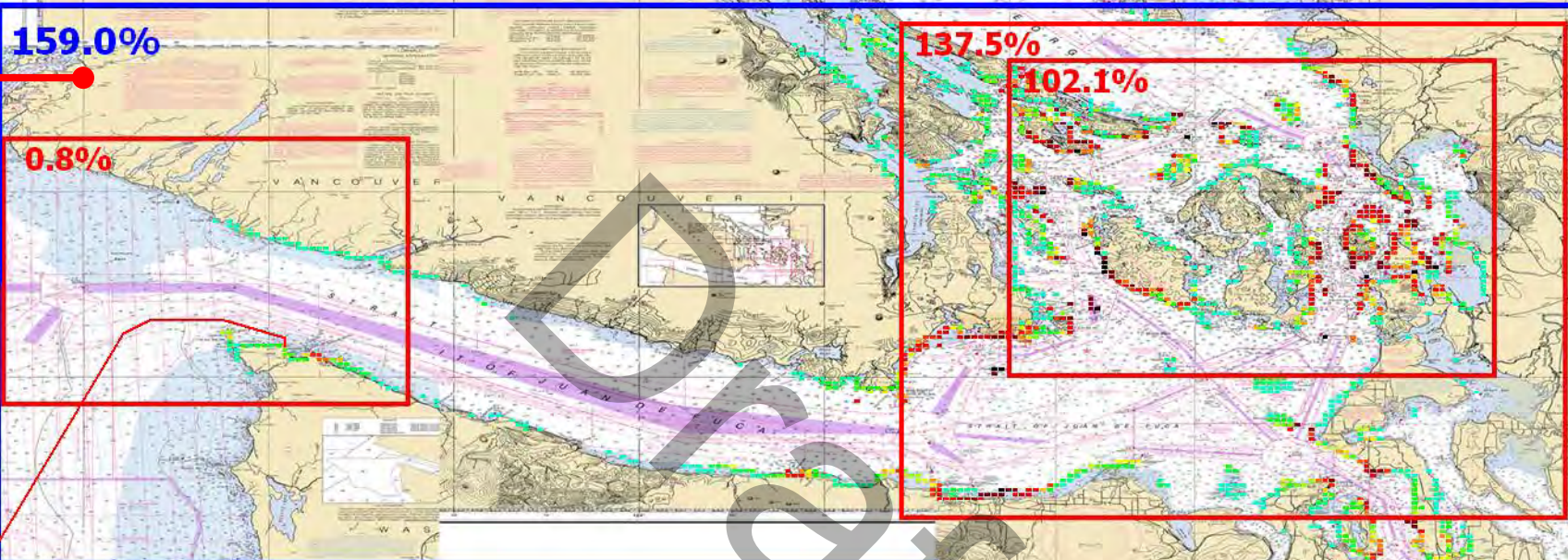
- P: POT. GROUND. OIL LOSS (PGO)**
- 06.7% - BULK CARGO
 - 18.8% - CONTAINERSHIP
 - 02.3% - OTHERCARGO
 - 02.3% - OIL BARGE
 - 54.8% - TANKER
 - 03.3% - CHEMICAL CARRIER
 - 11.8% - ATB
 - 00.0% - WHAT-IF FV

**100.0% of 2010 Base Case
ALL FV – PGO**



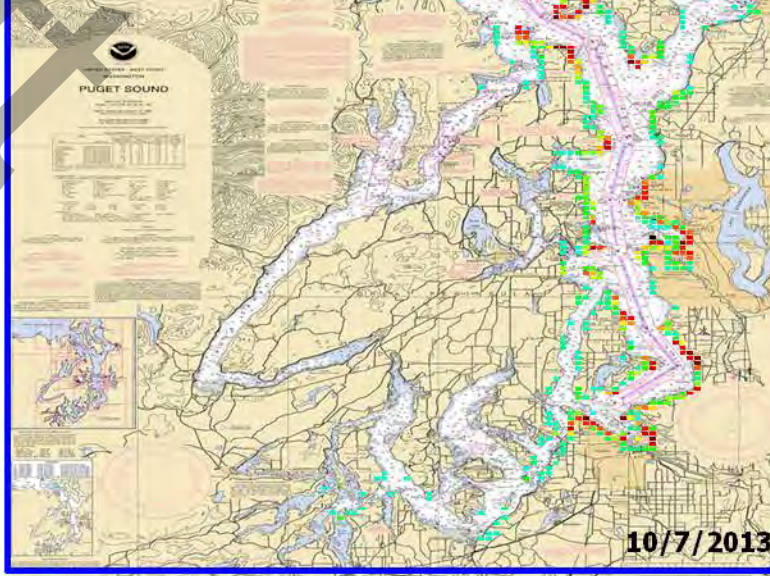
**T: ALL FV POTENTIAL
GROUNDING OIL (FUEL + CARGO) LOSS (PGO)**

T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348



- T: POT. GROUND. OIL LOSS (PGO)**
- 06.7% - BULK CARGO
 - 18.7% - CONTAINERSHIP
 - 02.3% - OTHERCARGO
 - 02.1% - OIL BARGE
 - 54.0% - TANKER
 - 03.3% - CHEMICAL CARRIER
 - 10.8% - ATB
 - 61.2% - WHAT-IF FV

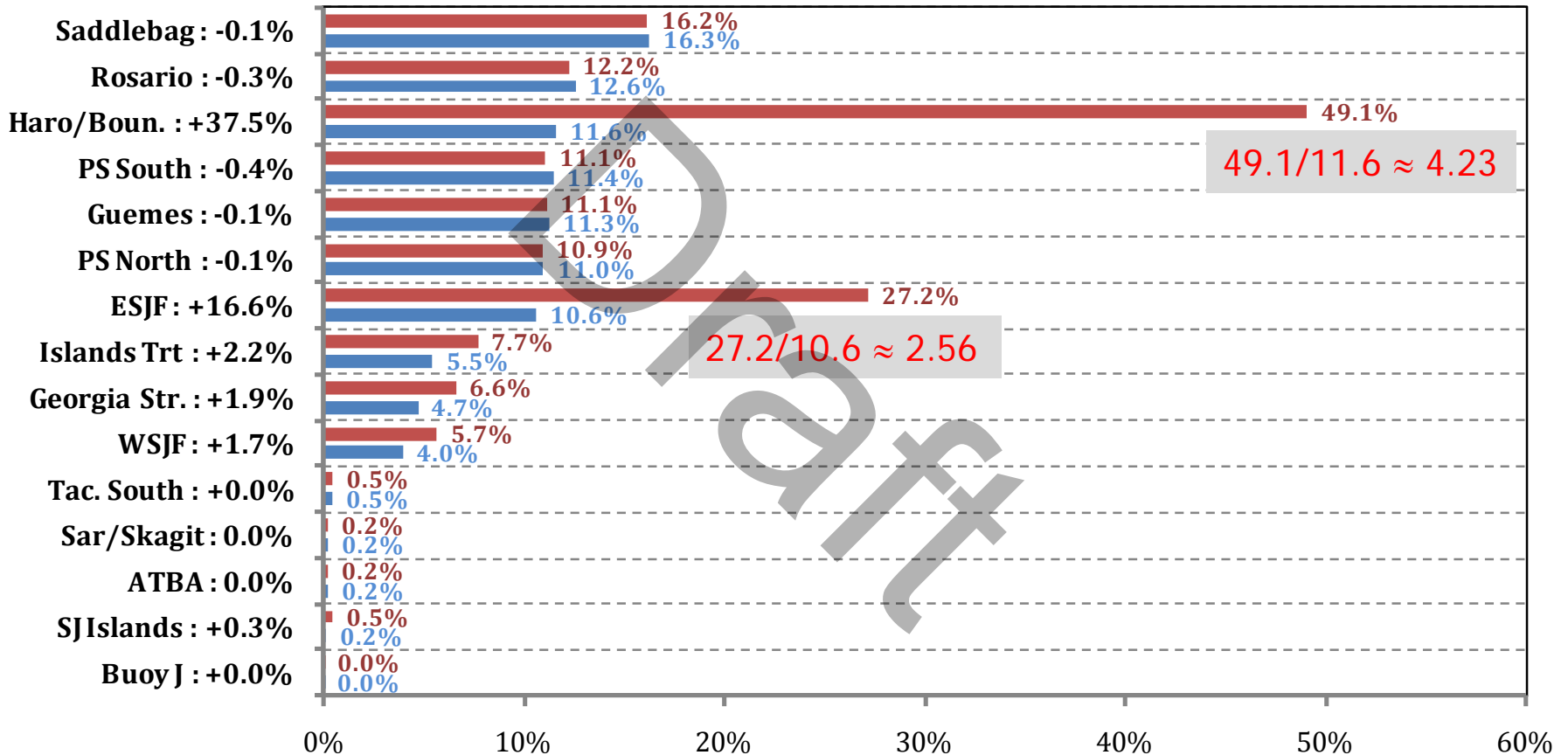
**+
159.0% of 2010 Base Case
ALL FV – PGO**



WATERWAY LOCATION

Potential Grounding Oil Loss Comparison – ALL FV

% Base Case Grounding Oil Loss - ALL_FV



49.1/11.6 ≈ 4.23

27.2/10.6 ≈ 2.56

59.2%
of 2010 Base Case
ALL FV – PGO

% Base Case Grounding Oil Loss (GOL) - ALL_FV

T: GW - KM - DP : 159.2%

P: BASE CASE : 159.2%

T: WHAT-IF FV POTENTIAL GROUNDING OIL (FUEL + CARGO) LOSS (PGO)

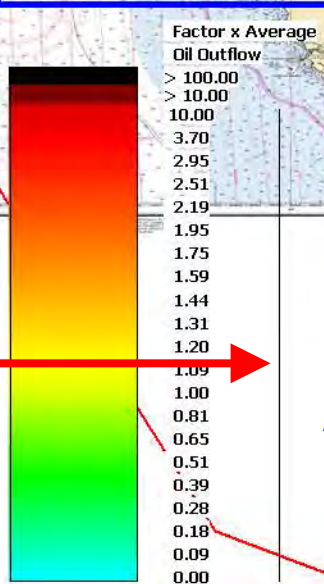
T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348

61.2%

0.2%

60.5%

43.3%



T: POT. GROUND. OIL LOSS (PGO)

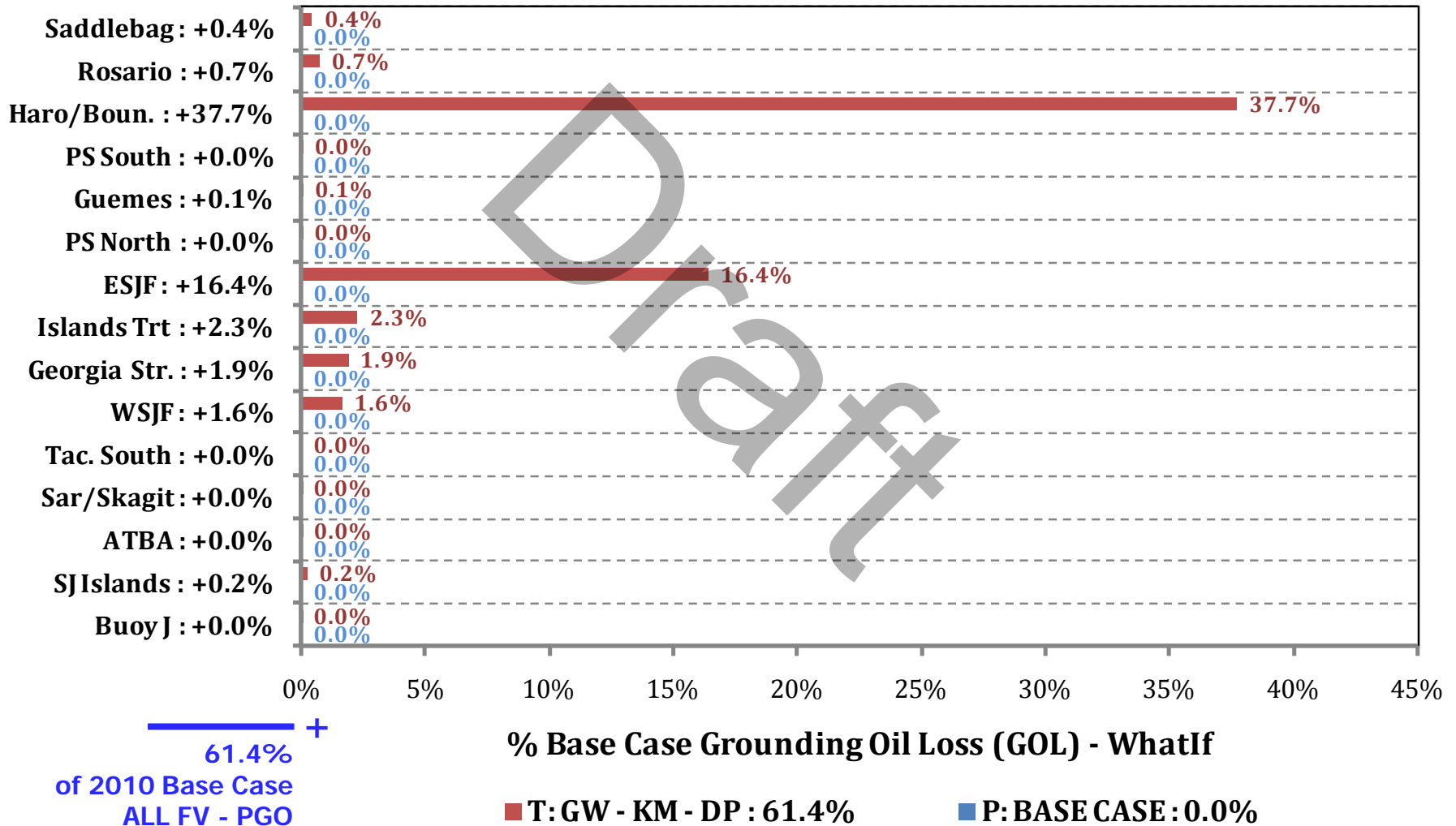
- 06.1% - BULKCARRIER
- 03.3% - CONTAINERSHIP
- 51.6% - OIL TANKER
- 00.3% - OIL BARGE

+
61.3% of 2010 Base Case
ALL FV – PGO

WATERWAY LOCATION

Potential Grounding Oil Loss Comparison – ALL FV

% Base Case Grounding Oil Loss - WhatIf



**P: ALL FV POTENTIAL
GROUNDING FUEL OIL LOSS (PGFO)**

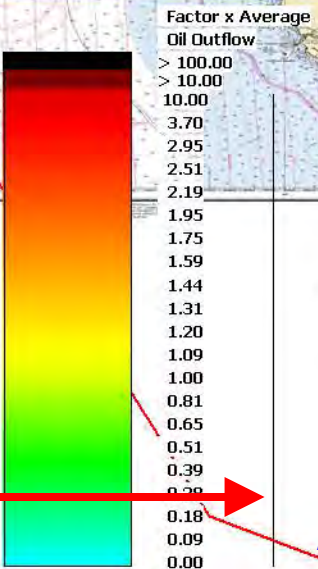
P: VTRA 2010 - BASE CASE

32.2%

0.1%

20.0%

13.4%

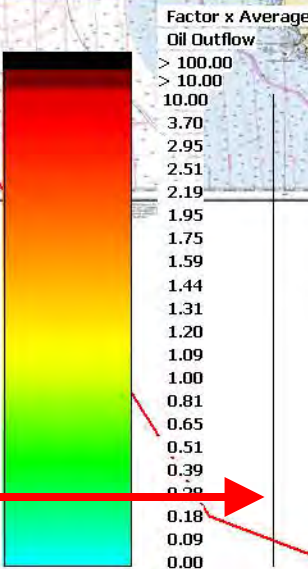
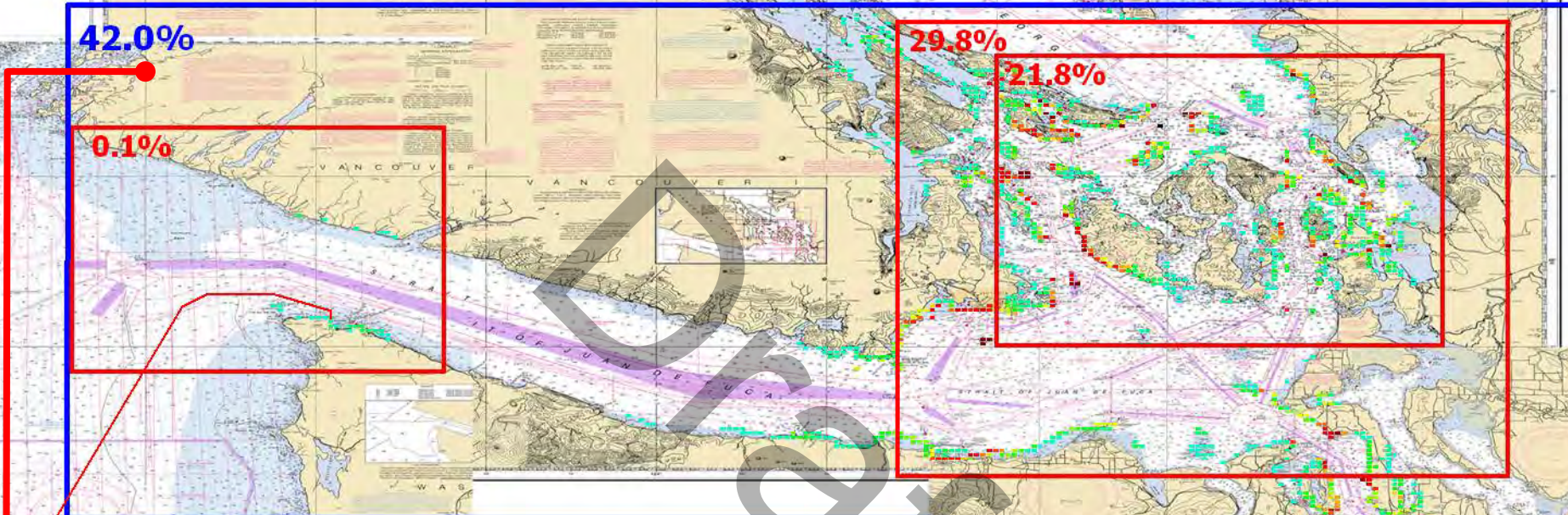


- P: POT. GROUND. FUEL OIL (PGFO)**
- 06.7% - BULK CARGO
 - 18.8% - CONTAINERSHIP
 - 02.3% - OTHERCARGO
 - 00.2% - OIL BARGE
 - 02.0% - TANKER
 - 00.2% - CHEMICAL CARRIER
 - 02.0% - ATB
 - 00.0% - WHAT-IF FV

**+
32.0% of 2010 Base Case
ALL FV - PGO**

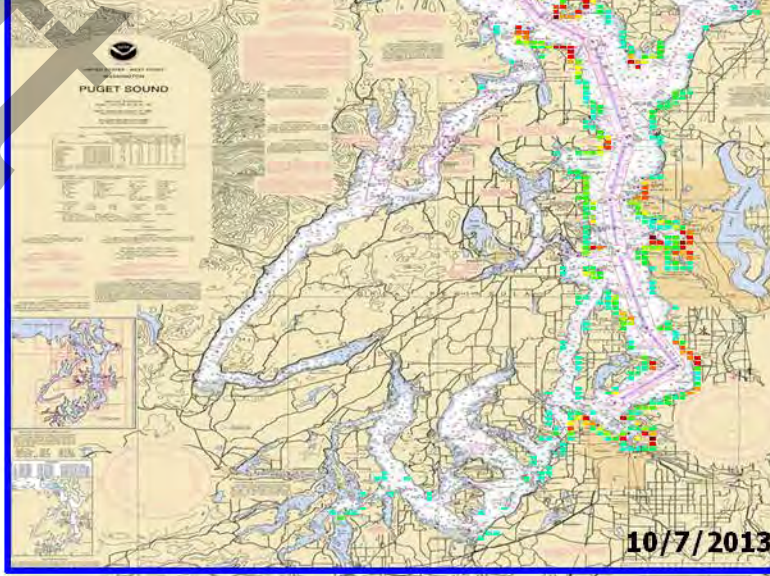
**T: ALL FV POTENTIAL
GROUNDING FUEL OIL LOSS (PGFO)**

T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348



- T: POT. GROUND. FUEL OIL (PGFO)**
- 06.7% - BULK CARGO
 - 18.7% - CONTAINERSHIP
 - 02.3% - OTHERCARGO
 - 00.2% - OIL BARGE
 - 02.0% - TANKER
 - 00.2% - CHEMICAL CARRIER
 - 01.8% - ATB
 - 10.2% - WHAT-IF FV

**+
42.0% of 2010 Base Case
ALL FV - PGO**



T: WHAT-IF FV POTENTIAL GROUNDING FUEL OIL LOSS (PGFO)



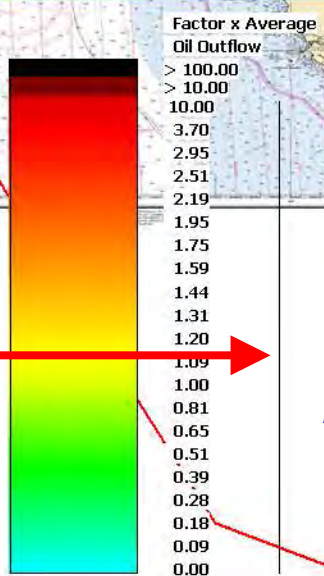
T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348

10.2%

0.0%

10.0%

8.6%



T: POT. GROUND. FUEL OIL (PGFO)

- 06.0% - BULKCARRIER
- 03.2% - CONTAINERSHIP
- 01.0% - OIL TANKER
- 00.0% - OIL BARGE

**10.2% of 2010 Base Case
ALL FV – PGO**

P: ALL FV POTENTIAL GROUNDING CARGO OIL LOSS (PGCO)

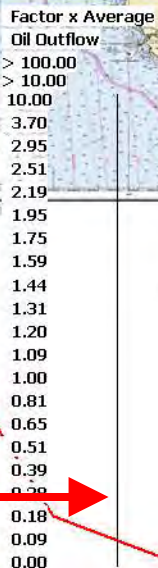
P: VTRA 2010 - BASE CASE

67.8%

0.5%

58.7%

47.2%



P: POT. GROUND CARGO OIL (PGCO)

- 00.0% - BULK CARGO
- 00.0% - CONTAINERSHIP
- 00.0% - OTHERCARGO
- 02.1% - OIL BARGE
- 52.8% - TANKER
- 03.1% - CHEMICAL CARRIER
- 09.8% - ATB
- 00.0% - WHAT-IF FV

+
67.8% of 2010 Base Case
ALL FV - PGO

T: ALL FV POVTENTIAL GROUNDING CARGO OIL LOSS (PGCO)

T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348

117.0%

0.7%

107.7%

80.3%

Factor x Average
Oil Outflow

- > 100.00
- > 10.00
- 10.00
- 3.70
- 2.95
- 2.51
- 2.19
- 1.95
- 1.75
- 1.59
- 1.44
- 1.31
- 1.20
- 1.09
- 1.00
- 0.81
- 0.65
- 0.51
- 0.39
- 0.29
- 0.18
- 0.09
- 0.00

T: POT. GROUND CARGO OIL (PGCO)

- 00.0% - BULK CARGO
- 00.0% - CONTAINERSHIP
- 00.0% - OTHERCARGO
- 01.9% - OIL BARGE
- 52.1% - TANKER
- 03.1% - CHEMICAL CARRIER
- 08.9% - ATB
- 51.0% - WHAT-IF FV

+
117.0% of 2010 Base Case
ALL FV - PGO

T: WHAT-IF FV POTENTIAL GROUNDING CARGO OIL LOSS (PGCO)



T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348

51.0%

0.1%

50.5%

34.7%

Factor x Average
Oil Outflow

- > 100.00
- > 10.00
- 10.00
- 3.70
- 2.95
- 2.51
- 2.19
- 1.95
- 1.75
- 1.59
- 1.44
- 1.31
- 1.20
- 1.09
- 1.00
- 0.81
- 0.65
- 0.51
- 0.39
- 0.28
- 0.18
- 0.09
- 0.00

T: POT. GROUND. CARGO OIL (PGCO)

- 00.0% - BULKCARRIER
- 00.0% - CONTAINERSHIP
- 50.8% - OIL TANKER
- 00.3% - OIL BARGE

— +
51.0% of 2010 Base Case
ALL FV – PGO