**Sets**

* P = [0, 1, 2] (0 – Brisbane, 1 – Sydney 2 - Melbourne)
* Q = [0, 1, 2, 3, 4, 5, 6, 7]
* H = [0, 1, 2, ,3, 4]
* H2 = [0, 1, 2, 3, 4, 5, 6, 7]

**Data**

* : Demand in port *i* in quarter *j* for diammonium phosphate
* : Demand in port *i* in quarter *j* for urea
* : Initial material stocks at port *i* for diammonium phosphate
* : Initial material stocks at port *i* for urea
* : Maximum storage space at port *p*
* : Cost for using small ship
* Big: Cost for using big ship
* : Cost for using port
* : Cost for storing
* : Capacity for each ship hold
* : Number of holds for small ship
* : Number of holds for big ship
* : Capacity for small ship
* : Capacity for big ship

**Variables**

* : Amount of diammonium phosphate to import to port p in quarter q
* : Amount of diammonium phosphate to store in port p in quarter q
* : Amount of urea to import to port p in quarter q
* : Amount of urea to store in port p in quarter q
* : Binary variable of whether ship goes to port p in quarter q
* : Binary variable of whether using small ship in quarter q
* : Binary variable of whether using big ship in quarter q
* : Binary variable of whether using h hold of small ship in quarter q
* : Binary variable of whether using h hold of big ship in quarter q

**Objective**

Minimise ))

**Constraints**

2. Q
3. Q
4. Q

7. Q
8. Q
9. Q
10. Q
12. Q Q
13. Q Q
14. Q
15. Q


19. Q
20. Q

|  |  |
| --- | --- |
| No. | Constraints |
| 1 | Ensures using only small or big ship |
| 2 | Ensures imported amounts don’t exceed the ship capacity for each quarter |
| 3 - 6 | Keep track of the inventory, ensuring that unused fertiliser is carried over to the next quarter. |
| 7 - 10 | Ensures amounts delivered and stored will be non-negative. |
| 11 | Ensures imported amounts don’t exceed the ship capacity for each port in each quarter(Binary variable control) |
| 12 - 13 | Ensures binary variable of each hold is compatible with ship binary variable |
| 14 -15 | Ensures imported amount doesn’t exceed the numbers of holds |
| 16 | Ensures big ship doesn’t deliver  for two quarters in a row |
| 17 - 18 | Ensures stored amount in the last quarter is the same as initial amount |
| 19 - 20 | Ensures stored amount doesn’t exceed the storing capacity |

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| **Shipping Schedule for Communication 6** | | | | | |
| **Quarter** | **Ship Type** | **Material** | **Brisbane** | **Sydney** | **Melbourne** |
| **1** | **Small** | **DAP** | 1,460 | 930 | 1,450 |
| **Urea** | 0 | 1160 | 0 |
| **2** | **Large** | **DAP** | 270 | 0 | 300 |
| **Urea** | 1,845 | 2,875 | 2,710 |
| **3** | **None** | **DAP** | 0 | 0 | 0 |
| **Urea** | 0 | 0 | 0 |
| **4** | **Large** | **DAP** | 2,740 | 3,360 | 1,820 |
| **Urea** | 80 | 0 | 0 |
| **5** | **Small** | **DAP** | 0 | 0 | 3,700 |
| **Urea** | 0 | 0 | 590 |
| **6** | **Small** | **DAP** | 2,420 | 3,250 | 1,750 |
| **Urea** | 580 | 0 | 0 |
| **7** | **Large** | **DAP** | 1,450 | 960 | 1590 |
| **Urea** | 1,730 | 500 | 1770 |
| **8** | **Small** | **DAP** | 1,110 | 110 | 390 |
| **Urea** | 0 | 0 | 515 |

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| **Storing Schedule for Communicaiton 6** | | | | |
| **Quarter** | **Material** | **Brisbane** | **Sydney** | **Melbourne** |
| **1** | **DAP** | 1,500 | 1,950 | 2,300 |
| **Urea** | 155 | 1,250 | 350 |
| **2** | **DAP** | 940 | 960 | 1,430 |
| **Urea** | 1,500 | 3,380 | 2,300 |
| **3** | **DAP** | 0 | 0 | 0 |
| **Urea** | 935 | 2,895 | 1,465 |
| **4** | **DAP** | 1,500 | 2,240 | 10 |
| **Urea** | 465 | 2,400 | 750 |
| **5** | **DAP** | 670 | 1,180 | 2,300 |
| **Urea** | 0 | 1,990 | 615 |
| **6** | **DAP** | 1,500 | 3,400 | 2,300 |
| **Urea** | 0 | 1,440 | 0 |
| **7** | **DAP** | 1,500 | 3,400 | 2,300 |
| **Urea** | 1,235 | 1,375 | 930 |
| **8** | **DAP** | 1,500 | 2,100 | 1,800 |
| **Urea** | 700 | 600 | 900 |

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| **Shipping Schedule for Communication 7** | | | | | | |
| **Quarter** | **Ship Type** | **Material** | **Ship Holds Required** | **Brisbane** | **Sydney** | **Melbourne** |
| **1** | **Large** | **DAP** | 5 | 1,460 | 2,050 | 1,450 |
| **Urea** | 2 | 0 | 0 | 1601 |
| **2** | **Large** | **DAP** | 1 | 270 | 0 | 300 |
| **Urea** | 7 | 1,845 | 4,055 | 1,100 |
| **3** | **None** | **DAP** | 0 | 0 | 0 | 0 |
| **Urea** | 0 | 0 | 0 | 0 |
| **4** | **Large** | **DAP** | 7 | 2,740 | 0 | 4110 |
| **Urea** | 1 | 250 | 0 | 0 |
| **5** | **Small** | **DAP** | 5 | 0 | 4070 | 0 |
| **Urea** | 0 | 0 | 0 | 0 |
| **6** | **Large** | **DAP** | 7 | 2,420 | 1,420 | 3,160 |
| **Urea** | 1 | 410 | 0 | 590 |
| **7** | **Large** | **DAP** | 4 | 1,450 | 960 | 1,590 |
| **Urea** | 4 | 1,715 | 0 | 2,285 |
| **8** | **Small** | **DAP** | 2 | 1,110 | 110 | 390 |
| **Urea** | 1 | 15 | 480 | 0 |

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| **Storing Schedule for Communicaiton 7** | | | | |
| **Quarter** | **Material** | **Brisbane** | **Sydney** | **Melbourne** |
| **1** | **DAP** | 1,500 | 3,070 | 2,300 |
| **Urea** | 155 | 90 | 1,960 |
| **2** | **DAP** | 940 | 2,080 | 1,430 |
| **Urea** | 1,500 | 3,400 | 2,300 |
| **3** | **DAP** | 0 | 1,120 | 0 |
| **Urea** | 935 | 2,915 | 1,465 |
| **4** | **DAP** | 1,500 | 0 | 2,300 |
| **Urea** | 635 | 2,420 | 750 |
| **5** | **DAP** | 670 | 3,010 | 890 |
| **Urea** | 170 | 2,010 | 25 |
| **6** | **DAP** | 1,500 | 3,400 | 2,300 |
| **Urea** | 0 | 1,460 | 0 |
| **7** | **DAP** | 1,500 | 3,400 | 2,300 |
| **Urea** | 1,220 | 895 | 1445 |
| **8** | **DAP** | 1,500 | 2,100 | 1,800 |
| **Urea** | 700 | 600 | 900 |

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| **Shipping Schedule for Communication 8** | | | | | | |
| **Quarter** | **Ship Type** | **Material** | **Ship Holds Required** | **Brisbane** | **Sydney** | **Melbourne** |
| **1** | **Small** | **DAP** | 4 | 1,460 | 1,090 | 1,450 |
| **Urea** | 1 | 610 | 0 | 0 |
| **2** | **Large** | **DAP** | 1 | 0 | 0 | 0 |
| **Urea** | 7 | 1,235 | 4,055 | 2,710 |
| **3** | **Smal** | **DAP** | 0 | 270 | 0 | 300 |
| **Urea** | 0 | 0 | 0 | 250 |
| **4** | **Large** | **DAP** | 7 | 1,830 | 4,360 | 1,810 |
| **Urea** | 1 | 0 | 0 | 0 |
| **5** | **Small** | **DAP** | 5 | 290 | 0 | 3710 |
| **Urea** | 0 | 660 | 0 | 340 |
| **6** | **Small** | **DAP** | 5 | 3,040 | 1,960 | 0 |
| **Urea** | 0 | 0 | 0 | 0 |
| **7** | **Large** | **DAP** | 4 | 660 | 0 | 3,340 |
| **Urea** | 4 | 1,730 | 0 | 2,270 |
| **8** | **Small** | **DAP** | 3 | 1,900 | 1,200 | 390 |
| **Urea** | 1 | 0 | 480 | 15 |

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| **Storing Schedule for Communicaiton 8** | | | | |
| **Quarter** | **Material** | **Brisbane** | **Sydney** | **Melbourne** |
| **1** | **DAP** | 1,500 | 2,110 | 2,300 |
| **Urea** | 765 | 90 | 350 |
| **2** | **DAP** | 670 | 1,120 | 1,130 |
| **Urea** | 1,500 | 3,400 | 2,300 |
| **3** | **DAP** | 0 | 160 | 0 |
| **Urea** | 935 | 2,915 | 1,715 |
| **4** | **DAP** | 590 | 3,400 | 0 |
| **Urea** | 385 | 2,420 | 1000 |
| **5** | **DAP** | 50 | 2,340 | 2,300 |
| **Urea** | 580 | 2,010 | 615 |
| **6** | **DAP** | 1,500 | 3,270 | 550 |
| **Urea** | 0 | 1,460 | 0 |
| **7** | **DAP** | 710 | 2,310 | 2,300 |
| **Urea** | 1,235 | 895 | 1,430 |
| **8** | **DAP** | 1,500 | 2,100 | 1,800 |
| **Urea** | 700 | 600 | 900 |