ately to the pollution damage that is caused. Pollution stabilization measures enacted in the World3 pollution sector in 2020 left the ultimate ambient pollution levels 4 times as great as when the same policies were enacted in the year 2000.

Although these inclusions are derived from hypothetical exogenous inputs from the other sectors of World3, they will facilitate an understanding of the behavior of the pollution sector once it is immersed in the remainder of World3. Chapter 7 tests the behavior of the entire world model when the dynamic behavior of all variables is endogenously determined over time.

APPENDIX A: PROGRAM LISTING

```
                POLTR
                NOTE
                NOTE    PERSISTENT POLLUTION SECTOR WITH EXOGENOUS INPUTS
                NOTE
          137   R       PPGR.KL=(PPGIO.K*PPOAO.K)*(PPOF.K)
          138   A       PPGF.K=CLIP(PPGF2.K,PPGF1,TIME.K,PYEAR)
                C       PPGF1=1
                A       PPGF2.K=SWITCH(PPGF21,PPGF22.K,SWAT)
                C       PPGF21=1
          139   A       PPGIO.K=PCRUM.K*POP.K*FRPM*IMEF*IMTI
                C       FRPM=.02
                C       IMEF=.1
                C       IMTI=10
          140   A       PPGNO.K=AIPH.K*AL.K*FIPM*AMTI
                C       FIPM=.001
                C       AMTI=1
          141   R       PPAPR.KL=DELAY3(PPGR.JK,PPTD.K)
                A       PPTD.K=CLIP(PPTD2,PPTD1,TIME.K,PYEAR)
                C       PPTD1=20
                C       PPTD2=20
          142   L       PPOL.K=PPOL.J+(DT)(PPAPR.JK-PPASR.JK)
                N       PPOL=PPOLI
                C       PPOLI=2.5E7
          143   A       PPOLX.K=PPOL.K/PPOL70
                C       PPOL70=1.36E8
          144   R       PPASR.KL=PPOL.K/(AHL.K*1.4)
          145   A       AHLM.K=TABHL(AHLMT,PPOLX.K,1,1001,250)
                T       AHLMT=1/1/21/31/41
          146   A       AHL.K=AHL70*AHLM.K
                C       AHL70=1.5
                NOTE
                NOTE    EXOGENOUS INPUTS TO THE PERSISTENT POLLUTION SECTOR
                NOTE
                NOTE    TABLE FUNCTIONS FOR CONTINUED MATERIAL GROWTH
                NOTE
                A       PCRUM.K=TABHL(PCRUMT,TIME.K,1900,2100,20)*1E-2
                T       PCRUMT=17/30/52/78/138/280/480/660/700/720/720
                A       POP.K=TABHL(POPT,TIME.K,1900,2100,20)*1E9
                T       POPT=16/19/22/31/42/53/67/86/109/139/176
                A       AIPH.K=TABHL(AIPHT,TIME.K,1900,2100,20)
                T       AIPHT=6.6/11/20/34/57/97/168/290/495/845/1465
                A       AL.K=TABHL(ALT,TIME.K,1900,2100,20)*1E8
                T       ALT=9/10/11/13/16/20/24/26/27/27/27
                NOTE
                NOTE    ADAPTIVE TECHNOLOGICAL CONTROL CARDS
                NOTE
                C       SWAT=0
                A       PPGF2I.K=DLINF3(PCTI.K,TDD)
                C       TDD=10
                L       PCTI.K=PCTI.J+(DT)(PCTIR.JK)
                N       PCTI=1
                R       PCTIR.KL=CLIP(PCTI.K*PCTCM.K,0,TIME.K,PYEAR)
                A       PCTCM.K=TABHL(PCTCMT,1-PLMF.K,0,.10,.10)
                T       PCTCMT=0/-.05
                A       PLMF.K=DLINF3(LMP.K,PD)
                C       PD=5
                NOTE
                NOTE    POLLUTION DAMAGE FUNCTIONS
                NOTE
                A       LMP.K=CLIP(LMP2.K,LMP1.K,TIME.K,PYEAR)
                A       LMP1.K=TABHL(LMP1T,PPOLX.K,0,100,10)
```



```
                T       LMP1T=1/.99/.97/.95/.90/.85/.75/.65/.55/.40/.20
                A       LMP2.K=TABHL(LMP2T,PPOLX.K,0,100,10)
                T       LMP2T=1/.99/.97/.95/.90/.85/.75/.65/.55/.40/.20
                A       LFDR.K=CLIP(LFDR2.K,LFDR1.K,TIME.K,PYEAR)
                A       LFDR1.K=TABHL(LFDR1T,PPOLX.K,0,30,10)
                T       LFDR1T=0/.1/.3/.5
                A       LFDR2.K=TABHL(LFDR2T,PPOLX.K,0,30,10)
                T       LFDR2T=0/.1/.3/.5
                NOTE
                NOTE    CONTROL CARDS
                NOTE
                N       TIME=1900
                C       PYEAR=1975
                SPEC    DT=1/LENGTH=2100/PRTPER=0/PLTPER=5
                PLOT    PPGR=G,PPAPR=A,PPASR=S(0,2E9)/PPOLX=X(0,100)/
                X       AHL=H(0,40)/LMP=L(0,1)/LFDR=D(0,.5)
                RUN     STANDARD
                NOTE
                NOTE    PARAMETER CHANGES FOR THE POLLUTION SECTOR RUNS
                NOTE
                NOTE    RUNS SHOWING RESPONSE TO PULSE AND STEP INPUTS
                NOTE
                NOTE    ** THE FOLLOWING CHANGE MUST BE MADE IN EDIT MODE:
                NOTE    ** R PPGR.KL=1E10*CLIP(1,0,TIME.K,1920)*CLIP(0,1,TIME.K,1922)
                C       PLTPER=2
                C       LENGTH=1980
                C       PPOLI=0
                PLOT    PPGR=G(0,1E10)/PPAPR=A,PPASR=S(0,1E9)/PPOLX=X(0,24)/
                X       AHL=H(0,40)/LMP=L(0,1)/LFDR=D(0,.5)
                RUN     FIGURE 6-26: PULSE INPUT
                NOTE    ** THE FOLLOWING CHANGE MUST BE MADE IN EDIT MODE:
                NOTE    ** R PPGR.KL=STEP(1E9,1920)*STEP(-1E9,2000)
                C       PPOLI=0
                PLOT    PPGR=G,PPAPR=A,PPASR=S(0,1E9)/PPOLX=X(0,40)/
                X       AHL=H(0,40)/LMP=L(0,1)/LFDR=D(0,.5)
                RUN     FIGURE 6-27: STEP INPUT
                NOTE
                NOTE    HISTORICAL RUN
                NOTE
                C       PLTPER=2
                C       LENGTH=1970
                PLOT    PCRUM=R(0,1)/POP=P(0,4E9)/AL=L(0,2E9)/
                X       AIPH=S(0,50)/PPGR=G(0,2E8)
                RUN     FIGURE 6-28: HISTORICAL RUN INPUTS
                C       PLTPER=2
                C       LENGTH=1970
                PLOT    PPGR=G,PPAPR=A,PPASR=S(0,2E8)/PPOLX=X(0,1)/
                X       AHL=H(0,2)/LMP=L(0,1)/LFDR=D(0,.5)
                RUN     FIGURE 6-29: HISTORICAL RUN
                NOTE
                NOTE    RUN SIMULATING RESPONSE TO CONTINUED MATERIAL GROWTH
                NOTE
                PLOT    PCRUM=R(0,8)/POP=P(0,16E9)/AL=L(0,4E9)/
                X       AIPH=S(0,1500)/PPGR=G(0,8E9)
                RUN     FIGURE 6-30: POLLUTION CRISIS INPUTS
                PLOT    PPGR=G,PPAPR=A,PPASR=S(0,2E9)/PPOLX=X(0,100)/
                X       AHL=H(0,40)/LMP=L(0,1)/LFDR=D(0,.5)
                RUN     FIGURE 6-31: POLLUTION CRISIS
                NOTE
                NOTE    SENSITIVITY TESTS
                NOTE
                C       IMTI=1
                C       AMTI=.5
                C       PPOL70=4.03E7
                RUN     FIGURE 6-32: TOXICITY SENSITIVITY
                C       PPTD1=40
                C       PPTD2=40
                C       PPOL70=8.1967
                RUN     FIGURE 6-33: DOUBLE TRANSMISSION DELAY
                C       PPTD1=10
                C       PPTD2=10
                C       PPOL70=1.9E8
                RUN     FIGURE 6-34: HALVED TRANSMISSION DELAY
                T       AHLMT=1/21/41/61/81
                RUN     FIGURE 6-35: HIGHER AHL
                T       AHLMT=1/1/1/1/1
                RUN     FIGURE 6-36: CONSTANT AHL
                NOTE
                NOTE    RUNS SIMULATING TECHNOLOGICAL POLICIES
                NOTE
```