June
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BARDASOOR DAM PROJECT

FEASIBILITY STUDY AND DESIGN

Environmental Impact Assessment (EIA)Report

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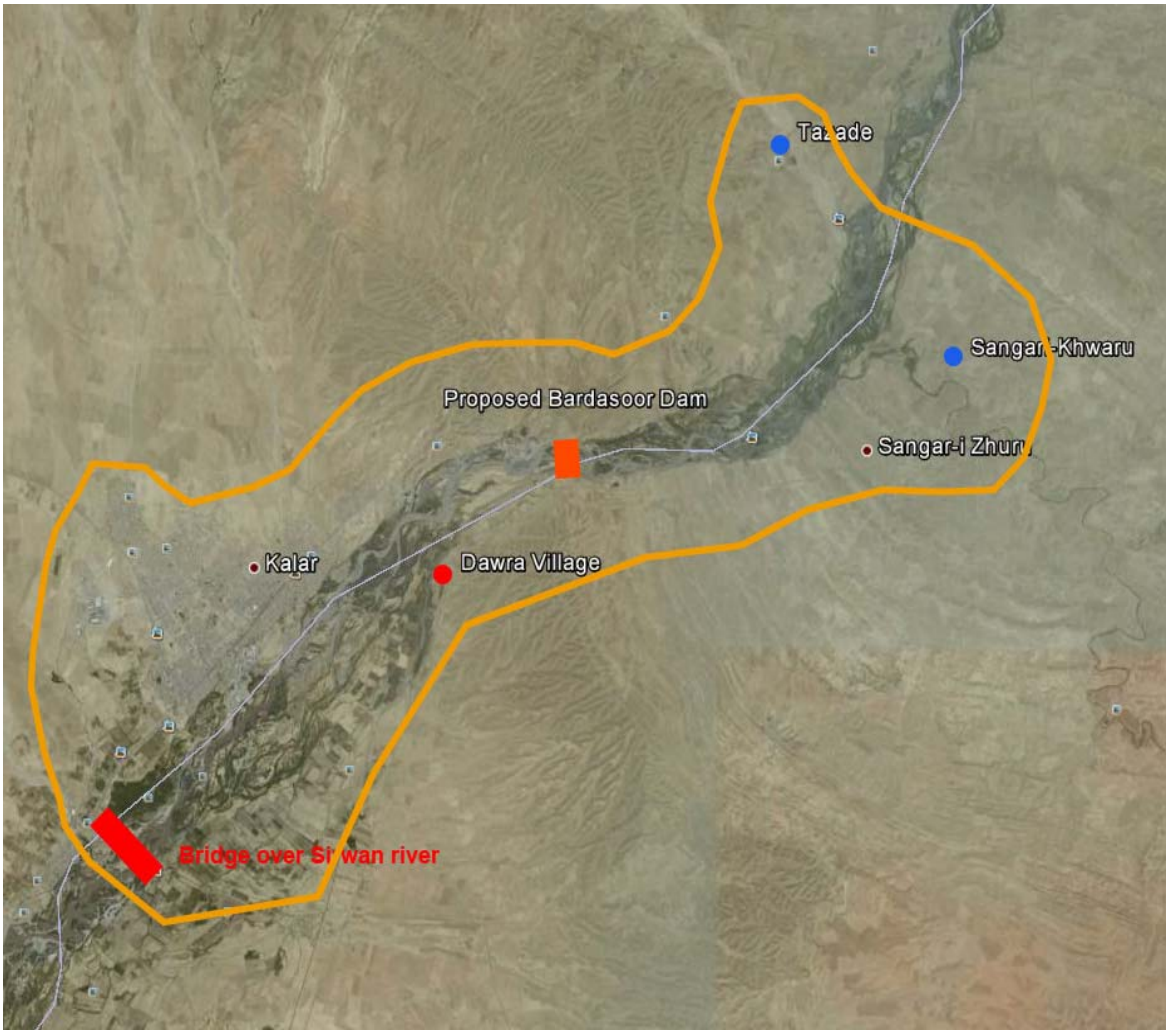
١١. Introduction

:

The studied area is described based upon the site investigation and all available maps and information.

Theproposed *Bardasoor*Damistobelocatedin the valley of the*Sirwan*River/ *Kalar/Kirkuk*/KurdistanGovernorate. The studied area from the upper part, on the left bank is bounded byTazade village valley and on the right bank is bounded bySangarykhwaru village,from the lower part,is bounded by kalar town on the right side and dawra village on the left side.TheLocationseeninfigure(1.1)isproposed forthedevelopmentof*Bardasoor*Dam located Northeasternofthe Kalar town.

Figure (1.1) illustrates the general map of studied area



Thedamreservoirareaisalmost(15.183km^2)atelevation247 m(whichistheelevation ofspillwaycrestlevel).Thefigure (1.1)and figure (1.2) showthatthere is one main source from Darbandikhan Dam dischargesitsflowtothedamreservoir. Andthere is Qoratooriver from East feeds up the reservoir.Thegeneralpurposefordeveloping*Bardasoor*dam istocontrolandstorewatertobeusedinirrigationandotherpurposes.

Figure (1.2) Qoratooriver

2.EIAPreparationBasis

TheEIAreportisprepared by the investigation and collection of information of the area and according torequestoftheministryofthewaterresources of*KURDISTANREGIONGOVERNORATE*. TheEIApreparationbasesanddetailswill dependuponthefollowing:

1.EIA laws,Chapter 5,PointsNo. 12, published by the ministry of Justice in

KurdistanRegionGovernment (KRG)thatpublishedintheweeklyFormal Newspaperof(KRG)No.90Vol.8inAugust,11,2008.

2. ThedetailsofEIAwilldependuponthetypicalimpactsofreservoirsanddams presentedbymanyresearchesandcasestudies.Inthisreporta collectionofEIApointedin(a)andadditionalEIAfromtheabovereferences are considered.

٣. EIAPurposes

TheProjectwillcauseimpactsontheenvironment ofthe*Bardasoor*damsiteand inundatedareatoacertainextent.Theenvironmentimpactassessment oftheproject istobecarriedoutinordertounderstandandmastertheenvironmentsituation beforeconstruction,toforecasttheenvironmentimpactsbytheconstructionofthe project through project pollution analysis ,to put forward feasible measures for pollutionprevention andtreatmentandimpactlessening,togiveoutbasisforproject decision,tosuperviseenvironmentprotectiondesignandenvironmentmanagementof theprojectandtoachieveeconomic,socialandenvironmentbenefitsatthesame time.

Morespecifically,thepurposesofthe*Bardasoor*damEIAare:

1- to improve the decision-making process by introducing environmental criteria and assessment to design engineers and decision makers and to ensure the Project is environmentally sound and sustainable.
2- to ensure adverse environmental impacts be identified and evaluated in the earlier stage of the Project development so as to develop appropriate measuresto avoid, mitigate, reduce or otherwiseminimize the adverse impacts to acceptable levels.
3- to develop measures of compensation for the impacts which could not be avoided or mitigated; and.
4- to provide a basis for Project executing agency and relevant government agencies to develop and implement plans for environmental management and monitoring.

4. GeneralScopeoftheDamSite:

Manyfieldinvestigationsareconductedin*Bardasoor*Damsite.Thefollowing generalscopepointsaredistinguished:

١. Manyhightensionelectricpolesarepresentedinthedamreservoirsite(from left bank to right bank) which must be relocated to another location, and there is another electric lines along the asphalt road in the left bank andtheywillbepartially inundatedafter construction of dam as shown in figure (4.1) and (4.2).

Figure (4.1) Electric Poles from left bank to right bank.

Figure *4.2* Electric poles in the left bank of the dam

٢. ThereisamainwaterStationlocatedinthedamdownstream site as shown in figure (4.3).

Figure (*4.3*) Water pump Station at downstream.

٣. There are two asphalt roads, one road is the main road between Kalar and Darbandikhan and located at the right side of the reservoir, the other road is the main road access road from villages to Maydan and located at the left side and will be partially inundatedafter construction of dam.

٤. Thereis an asphalt concrete plant at the right side of the reservoir in line with

Barloot village as shown in figure (4.4)

Figure (4.4) Asphalt concrete Plant.

٥. Thereisamany washing plant in the Valley of Sirwan River and they will be inundated after construction of dam, an example of them shown in figure (4.5).

Figure (4.5) Washing Plant.

٦. Thereare three villages (Banzamini-Said-Muhammed, Banzamini-Mala-Sulaiman,Subhan village, see figure (4.6), (4.7), and (4.8)) at the left side of the reservoir which will be inundated by the reservoir, therefore the villages must relocate to a safe place far from the reservoir (minimum 500 from maximum flood level of reservoir)

Figure (4.6) Subhan village.

Figure (4.7) Banzamini-Mala-Sulaiman village.

Figure (4.8) Banzamini-Said-Muhammed village.

٧. Therearemanyorchard and cultivated land in the valley and at the shore of the valley which they belong to the villages that surrounding the area and they will be inundated after construction of the dam.

Figure (4.9) Cultivated lands

٨. There are abundant of natural shrubsat different places in the Valley of Sirwan Riveras shown in figure (4.10) and they will be inundated after construction of the dam.

Figure (4.10) Abundant of shrubs

٩. There is a concrete irrigation canal (see figure (4.11))located at upstream of the dam and it partially will be inundated after construction of the dam.

Figure (4.11) Concrete Irrigation Canal at upstream.

١٠. There is a personal rest house at the upstream and at shore of the river and it will be inundated after construction of the dam.

Figure (4.12) Personal Rest house in the valley.

١١. Concrete canal at the downstream of the dam, see figure (4.13).

Figure (4.13) Concrete canal at the downstream.

١٢. There is an archeological building at the upstream and its history returns to time of Osman's and Russians Combats.

Figure (4.14) an archeological building at the upstream.

5.TheBaseLineofDamSiteArea:

When the quality of water (purer water) is good, it will affect positively on the process of water use for riverine (improvement of aquatic lives especially fishes), human usages and irrigation demands in terms of ecology and economy. In case of poor quality of water, conversely,themoreexpensiveitisto treattosatisfactory levels.

Thefollowingbaselineisconsideredinthereport:

1. Tables(5.1)aregeneralizedwaterqualitystandards forirrigation,drinkingandfresh-waterfisheriesasa baseline.
2. Iraqistandards forrivers,lakes,domesticoutfallsandindustrialoutfallsare alsoconsideredasa baseline.

Table (5.1) generalizedwaterqualitystandards forirrigation, drinkingandfresh-waterfisheries

Potential Irrigation Problem		Unit	Degree of Restriction on None	Slight to	Severe
Salinity (affects crop water availability)[2]					
EC_w		dS/m	<0.7	0.7-3.0	>3.0
(or)					
TDS		mg/l	<450	450-2000	>2000
Infiltration (affects infiltration rateof water into the soil. Evaluate using $EC_w$and SAR[3]					
SAR = 0-3 and	EC_w=		>0.7	0.7-0.2	<0.2
SAR =3-6	EC_w=		>1.2	1.2-0.3	<0.3
SAR =6-12	EC_w=		>1.9	1.9-0.5	<0.5
SAR =12-20	EC_w=		>2.9	2.9-1.3	<1.3
SAR =20-40	EC_w=		>5.0	5.0-2.9	<2.9
Specific Ion Toxicity (affects sensitive crops)					
Sodium(Na)[4]					
	surfaceirrigation	SAR	<3	3-9	>9
	sprinklerirrigation	me/l	<3	>3	
Chloride (Cl)[4]					
	surfaceirrigation	me/l	<4	4-10	>10
	sprinklerirrigation	me/l	<3	>3	
Boron (B)		mg/l	<0.7	0.7 - 3.0	>3.0
Miscellaneous Effects (affects susceptible crops)					
Nitrogen (NO_3- N)[5]		mg/l	<5	5-30	>30
Bicarbonate (HCO_3)(overhead sprinkling only)		me/l	<1.5	1.5 - 8.5	>8.5
pH			Normal Range6.5-8.4		

[1] Adapted from University of California Committee of Consultants 1974.

[2] ECw mean electrical conductivity, a measure of the water salinity, reported in deciSiemens per meter at 25°C (dS/m) or in units millimhos per centimeter (mmho/cm). Both are equivalent. TDS means total dissolved solids, reported in milligrams per liter (mg/l).

[3] SAR means sodium adsorption ratio. At a given SAR, infiltration rate increases as water salinity increases.

[4] For surface irrigation, most tree crops and woody plants are sensitive to sodium and chloride. Most annual crops are not sensitive. With overhead sprinkler irrigation and low humidity (<30 percent), sodium and chloride may be absorbed through the leaves of sensitive crops.

[5] NO3 - N means nitrate nitrogen reported in terms of elemental nitrogen (NH4 - N and Organic - N should be included when wastewater is being tested).

Table (5.2) DRINKING WATER STANDARDES OF EPA

Contaminant	Limit
Primary Standards (Maximum Contaminant Level, MCL)	
Total Coliforms (av. Number/100ml)	1
Total Coliforms (max. Number/100ml)	5
Turbidity (ntu)	1-5
Inorganic Chemicals (mg/l)	
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Fluoride	0.7-2.4
Lead	0.05
Nitrate (as N)	10
Selenium	0.01
Silver	0.05
Radionuclide (pCi/l)	
Gross alpha	15
Ra-226+ Ra-228	5
Gross Beta	50
H-3	20000
Sr-90	8
Organic Chemical (µg/l)	
Endrin	0.2
Lindane	40
Methoxychlor	100
Toxaphene	5
2,4-D	100
2,4,5-TP	10
Trihalomethanes	100
Benzene	0.05
Carbon Tetrachloride	0.05
1.2 Dichloroethane	0.05
Trichloroethylene	0.05
Para-Dichlorobenzene	0.75
1,1 Dichloroethylene	0.07
1,1,1 Trichloroethane	2.0
Vinyl Chloride	0.02
Secondary Standards (Recommended Contaminant Level, MCL)	
Chloride (mg/l)	250
Color (units)	15
Copper (mg/l)	1.0
Iron (mg/l)	0.3
Manganese (mg/l)	0.05
Oder (TON)	3
pH	6.5–8.5
Sulphate (mg/l)	250
Total dissolved solids (mg/l)	500
Zinc (mg/l)	5

TABLE 3 DRINKING WATER STANDARDES OF EPA

TABLE(5.3)Water qualityfor freshwaterfish(temperate zoneexcludingsalmonids)

Characteristic	Level at which no stress is
Dissolved oxygen	50%of the time≥7 mg/l O_2
Non-ionized ammonia	≤0.025mg/l NH_3

6.PredictionofImpactsArisingfromtheImplementationDuringtheConstructionalandOperationalPhases:

Manypositiveandnegativeimpactsduring constructionalandoperationalphases wereconsideredbymanyresearches.

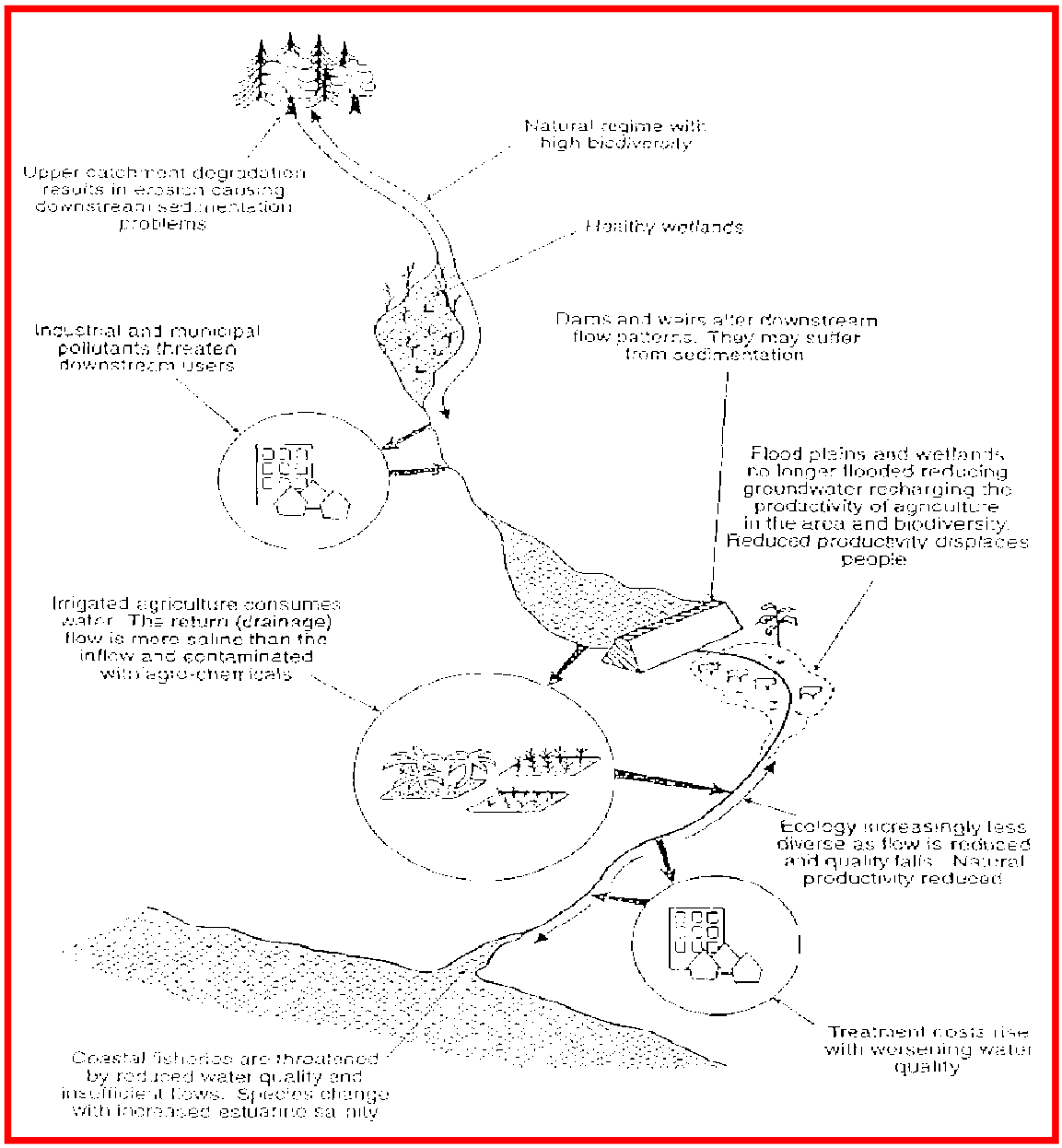
6.1 Topographyand land form

1.For Soil dam, there will be quarry sites for both core and shell construction material during and after construction of the dam, and subsequently it leads to a new form of those places.

2.Floods may cause topography and land form after operation phase.

3. Changes to the river morphology may result because of changes to theSedimentcarryingcapacityofthefloodwaters.

FIGURE6.1CausesandImpactsofReducedWaterQualityinaRiverSystem.



6.2. Reservoirsedimentation

Allriverscarrysomesediment astheyflowthroughtheirwatershed. Whenthe riverisheldbehindadamin thereservoir foralongperiodoftime,mostofthe sedimentwillbetrappedinthereservoir. Thesesedimentparticleswillsettleto thebottomofthereservoir,sothatthewaterreleasedfromthedamwillbebetter quality.

6.3. Soilerosion and Slope Stability

1. ErosionPotentialcreatedasa resultofaccessroadcreation inresponseto roadclosuresanddeviations.
2. The water that released from dam is much clear, inthat itwillrecapture itssedimentload byeroding thedownstreamriverbed andbanks.Overtime, theriverdownstreamofthe damwillbecomenarroweranddeeper.
3. Blasting (if it will be used as the last resort) will have impacts on the surrounding areas as wellasonthelocalcommunity.
4. Fissuring oftheunderlyingrockonwhichthedam wallwill beconstructed.
5. Erosion acceleration of riverbanksdownstream ofthe outflow may be caused by Regulationofrivers. Thismeansthat theenvironment of productivebanksideand slope stability isnegativelyaffected.

6.4. Flooding

Flood management today acknowledges thattheriverneedsspacetoaccommodatefloodpeaksandthat thewholeriverbasinmustbeconsidered.

Damshavebeenamajorcomponent asprotective leveesalongtheriversandto create reservoirs to store flood water and decrease flood peaks. This has, however, proved insufficient in many cases.

Reservoir flood will cause the stop of fluency of ground water and it will probably lead to reduction of auto-regulation and self-purification processes in ground water.

The dam must also be able to discharge incoming flows which, for various reasons, cannotbestoredinthereservoir. Thedesigncapacityofthespillway systemofthedamshouldtherefore alsobeabletocopewithextremely high inflowstothedam.Thisisofparticularimportanceinthecaseofdamsthatdo notwithstandovertoppingofthecrest,such asembankmentdams.Thissituation

mayariseiftheinflowtothedamoveracertainperiodexceedsthedischarge capacity ofthedam.Aclimatechangemaygiverisetomoreextreme floodsand mayrequirepreventivemeasures.
Uncontrolled floodscausetremendous damageandfloodcontrolistherefore oftenanaddedsocialandenvironmental benefitofreservoirsbuilttosupply irrigationwater.However,floodprotection works,althoughachievingtheir purposelocally,increasefloodingdownstream, whichneedstobetakeninto account.

6.5. Hydraulicriverflowregime

Theimpactsofalltheseabovechanges (that mentioned before)arefurthermagnified bychangesinthe flowpatternoftheriverdownstream.Drastichydrologicchanges,whetherin totalstreamflow,seasonaltimingofflows,orevenshort-termfluctuationsdueto damreleases,generatea rangeofimpactsonhydraulicriverflowregime.

6.6. Qualityand Self–purificationabilityofriver

Auto-regulation and Self–purificationability of any river dependsmainlyon its fluency, turbulences,quantityandqualityofitscontamination andtemperature.Auto-regulation and Self-purification abilityoftheriverdownstreamof*Bardasoor*damwillbeaffected negativelyasaresultoftheimpoundment andalterationoftheflowpattern duringdamconstructionandoperation and subsequently the quality of water will be affected.
Watertemperature, turbidity,dissolvedgasesand concentrationsofheavymetalswillallchangeasa resultoftheimpoundment.

6.7. Adequatedownstreamwaterflow

During the construction of dam,Inadequate waterflowmaybesuppliedtothevillagesandirrigationareas downstreamof*Bardasoor*.

6.8. WaterQualityofdamLake

Water quality in the dam reservoir will be probably endangered by faecal and

organic contamination.Whenwaterisheldwithinthereservoir,itstemperature increases,nutrientsare removed(astheysettleoutofthewatercolumn), Shrubs and pantsareflooded and decompose(raisingbiochemicaloxygendemandlevels),andlargematsofaquatic plantsmaycolonizetherelativelystagnantwatersofthereservoir. The contamination will be probably higher than in case of fluency water in river.Eachofthese effectsimpactsriverecology.Particularlysevereeffectsoftenoccurintheperiod shortlyfollowingimpoundment.Assubmergedvegetationandsoildecompose, oxygenisheavilydepleted.Thisde-oxygenatedwatercanbelethaltoaquaticlife withinthereservoiranddownstreamintheriver.

ThewaterqualityofSirwanRiver isexaminedfrom two samples.Thefirstsample had been taken from Sirwnriver itself.Theothersamplehad been taken from Qoratooriver which it discharges its water into Sirwan river .The samples are tested in Bani-Khelan water treatment plant. Table (6.1) shows the results of the tests. The table illustrates that 7 characteristics are examined and compared with the standard of drinking water, lakes and outfalls of domestic water. The comparison between samples characteristics and drinking water standard shows an increase in the concentration of Turbidity of both Samples, A comparison between the concentrations of the characteristics and the Iraqi Drinking Water Standards shows adecrease in the Calcium(Ca^{++}) and Sulfate $(SO^{-})^{4}$ of Sirwan river Sample.A comparison between the concentrations ofthecharacteristicsandtheIraqiDomesticWaterStandardsshows a decrease in Sulfate $(SO^{-})^{4}$ of Sirwan river Sample.

Table(6.1)Theresultsofsamplestestof Sirwan and Qoratoo river

No	Characteristicsin mg/L	Sirwan river	Qoratoo river	A	B*	C**
1	Turbidity (NTU)	14.3	4.8	5.5-10		
2	pH	7.4	7.8	6.5-8.2	6.5-8.5	6.-9.5
3	T.D.S.	200	390	500-1500		
4	Total Hardness	180	340	100-500		
5	Calcium(Ca^{++})	40	70	75-150		
6	Nitrate(NO_3)	7	2	50		
7	Sulfate(SO_4)	40	200	200-400	200	400

(*)=According toIraqi standards for Drinking Water.
(**)=AccordingtoIraqi standardsfor LakeWater.
(***)=AccordingtoIraqistandards for Domestic Water.

6.9. ThermalStratificationinDamReservoir

Anotherimportantpropertyofwateristhatdensityisgreatestat4°Cwater aboveorbelowthistemperaturewill overturnsonwaterat4°C.Also,warmerwaterfloats oncoolerwater.Thisdensitydifferentialperdegreeincreasesprogressively with highertemperatures. Duringtheyear,asthewaterbodywarmsandcools seasonally,thereisachangingtemperatureprofilewithdepth.Thishasdirectand indirecteffectsonanumberofecosystem processes. Astemperature increases, thisdiscontinuitybecomesmoremarkeduntilthewaterbodyisfullystratified intothreeparts:

١. Awarm**epilimnion**atthetop.
٢. Acold**hypolimnium**atthebottom.
٣. Anarrowregioninbetween,calledthe**thermocline**, wheretemperature changes rapidlywithdepth.Thiseffectively createsabarrierpreventing thetwowater bodiesfrombeingmixedbythesurfacewind.

Whenthesurfacewatersstarttocoolagain, thisstratificationmaylastthrough thesummer andintoautumn.Whenthewaterbodyasawholereachesasimilartemperatureagain,windcanmixthe wholereservoirwaterfromtoptobottom,causingtheoverturn. Thermal stratificationhasmajor effectsonbothoxygenconcentrationand nutrientsupplies.Whenthelakeisstratified, nomixingoccursbetweenthetop andbottomlayers.Thehypolimniomreceivenooxygen thathasdiffusedintothe surfacewatersbecomesincreasinglyanoxic.Theepilimnion,wheretheplantsare, receivesnodissolvednutrientsfrom thebottom,wheredecompositionoccurs,so primaryproductivity becomesnutrientlimitedanddeclinedoverthesummer. Whentheoverturnoccurs,thehypolimniumisreplenishedwithoxygenandthe epilimnionwithdissolvednutrients. Anendresultofsuchseasonalcyclesis seasonalbloomsofphytoplankton, duetothereplenishmentofnutrientsin autumnandincreasingtemperatures andlightlevelsinspring.Excessive Deoxygenationofthehypolimniuminsummer,whichcanariseasaresultof strongeutrophicationofthewaterbody,canresultindramaticdisturbancesto therestofthelakesystemonoverturn anddecreasing qualityofthewater resources.

Reservoirsaredefinedwithrespecttostratification bytheirdensiometricFroud numberas:

Densiometricnumber:$\mathbf{F_D=V/SQR(\Delta\rho D_g/\rho_o)}$

$\mathbf{\rho_o}$=referencedens
ity.

$\mathbf{\Delta\rho}$=densitychangeoverdepth**D**

. If$\mathbf{F_D}$>0.32→nostratification

0.01<$\mathbf{F_D}$<0.32→moderatelystratifi
ed

If$\mathbf{F_D}$<0.32→stronglystratifie
d

If there is no flow or low flow especially

insummeri.e.,**Q**=0→V=0→$\mathbf{F_D}$=0Where**Q**=discharge.

So, for the case of very low discharge, *Bardasoor*reservoir is <u>stronglystratified.</u>

6.10. EutrophicationinDamReservoir

Anincreaseintheconcentrationofnutrientsintheaquaticecosystemof*Bardasoor*reservoircauses:

١. The increased productivity of autotrophic green plants, leading to the blockingoutofsunlight.
٢. Elevatedtemperatureswithinthewaterbodyofthereservoir.
٣. Depletionofthewater'soxygenresources.
٤. Increasedalgalgrowth.

Eutrophication indamreservoirimpactmayresultfromthevegetation coverand Shrubs inthe reservoirareabeforeinundationasshowninfigure(6.2).

Figure (6.2)Vegetationcover inthereservoir area

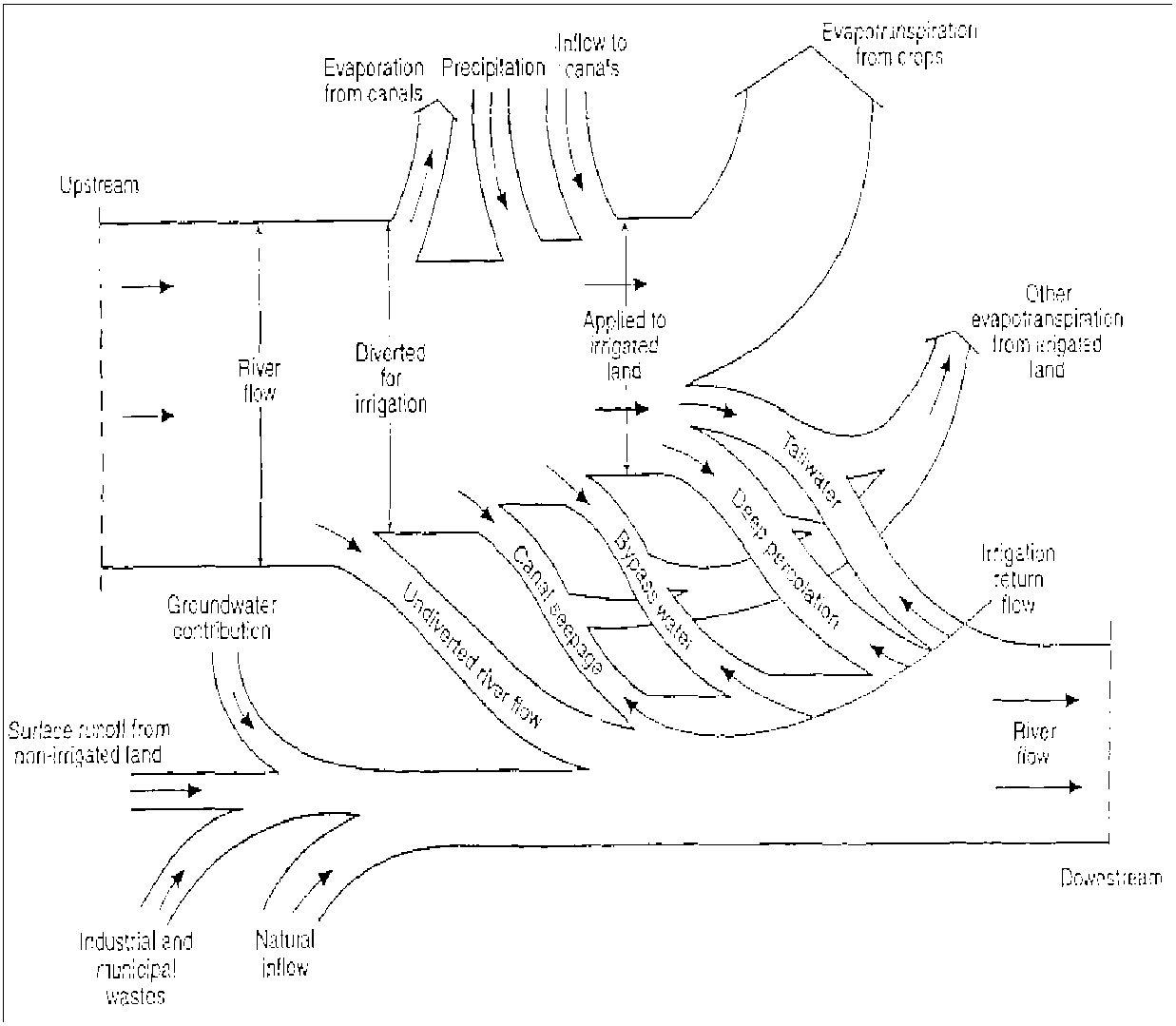
6.11. GroundWaterTable

Theinundation ofupstream siteof*Bardasoor*damwillcausesanincreasein

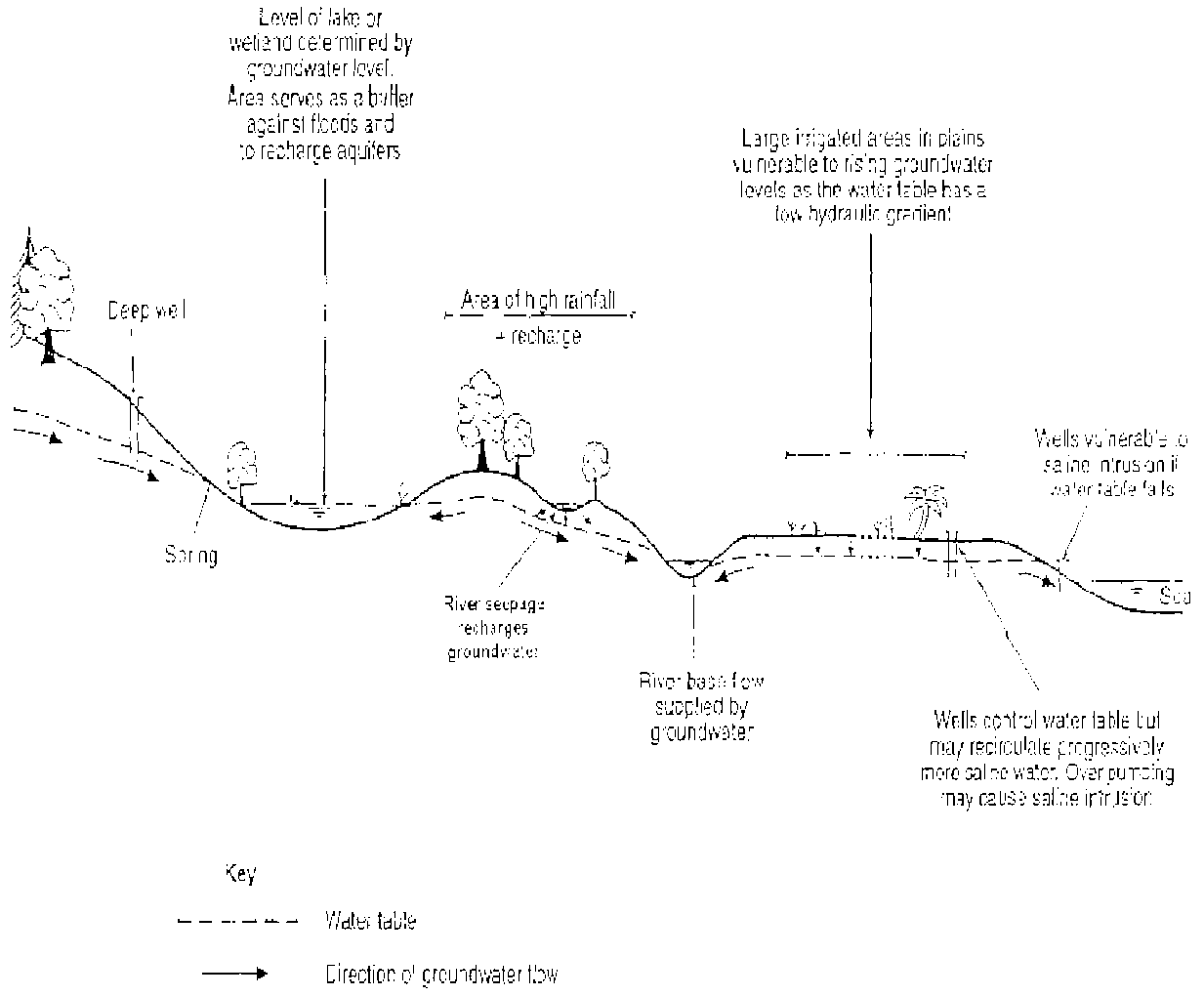
thegroundwatertable in the surrounding area.Thisincreaseofgroundwatertablewill lead to reduction of auto-regulation and self-purification processes and surface water quality will be decreased by fecal and organic contamination.

The Oxygen content in water will decrease due auto-regulation and self-purification of the water in the reservoir.

FIGURE(6.3)Conceptualdiagramoftheirrigationreturnflowsystem for agivenreachofariver system (UtahStateUniversityFoundation,1969).



FIGURE(6.4).The interrelationshipsbetweensurface water andgroundwater.



6.12. Qualityofgroundwater

The quality of ground water is governed by the character of the hydrogeological aquifer and the residence time of water in the rock medium. The water quality will probably change in relation to the recharge of precipitation.

Thedegradationofreservoirwaterpropertiesupstreamof*Bardasoor*damwill causeadegradationofgroundwaterquality.

Changes in the water quality can be expected during the year in relation to whether it is a rainy season or a dry season. In the period when the stream is recharged only by ground water, a higher content of dissolved substances can be assumed.

6.13. Climatology andEvaporation

Increasing of evaporation of the reservoirespeciallyinsummer willimprove microclimate andtheair humidity and it may influence the dust pollution of air.Thisisduetothewaterinundation of upstreamsiteof*Bardasoor*dam.

6.14. Aquaticlife,TerrestrialwildlifeandSensitivehabitats

Due to high population density and intensive utilization of landscape, there are not big herbivores and ferine,they lost mostly their habitat at the area.

Areservoirupstream of*Bardasoor*damwillfloodpartofriverbed,floodplain,uplandhabitat and villages.Thereservoir mayinundate avarietyofterrestrial andriver habitattypes,includingsensitive habitats.Thecreationofreservoirs provides the possibilityofenhanced aquatichabitats.Inparticular reservoirsoffersthe opportunityofpisciculture and aquacultureandfavorablehabitatsforwaterfowl, bothpermanent andmigrating,butmayalsoofferfavorablehabitatsfordisease transmitting insectsandsnails.Birdsanctuaries andwildlifeparkscanbecreated aroundreservoirs.Figure(6.5)showsgroupofsheepbrowsing near*Bardasoor*Riverandinthereservoirarea.

Figure (6.5)GroupsofSheepbrowsingnear*Sirwan*River andinthereservoir area

Almostalldamsreducenormalflooding,effectively isolatingtheriverfromits floodplain.Numerousaquaticandterrestrialspecieswillbeunabletoadaptto thesechangesinwaterlevelsandflowregimes.Thewholeecosystem will experience adropinspeciesdiversity,withafewernumberofspeciesingreater abundancesremainingandthrivinginthedisturbedconditions.

6.15. Endangeredfaunaandendangeredflora

Sinceflooddischargeisreduced,transportandsedimentation conditionsare changed, whichalterstheriverbottom anditsbiologicalsignificance. Ina naturallyflowing river,changesinlevelhaveanannual rhythmwhichmakes fora specificfloraandfaunaregardingbothspeciescompositionandstructure.The alteredrhythmofwaterlevelina regulatedriveraffectsmanyorganisms. Areductionofbiodiversity followingconstruction ofa*Bardasoor*damand reservoir isalmostinevitable.Thisprojecttendstofragmentriverineecosystems, isolatingaquaticpopulationslivingupstreamanddownstream ofthedamand cuttingoffmigrationpathways.

6.16. Vegetationcoverage

Vegetation cover of the area is heavily influenced by human effects especially by livestock grazing, agricultural and gravel mining in the river bed. The agricultural cultivated lands mostly located at high flat area surrounding the reservoir and most of these lands include un-irrigated field where wheat and barley are mostly grown and irrigated field where rice, cucumber, melons, tomatoes, potatoes, legumes, and others grown. The most lands used for livestock grazing include the fields where covered by grasses and unsuitable for agricultural purposes especially somewhere that has steep slope or unfertile soil. Also there are agricultural cultivated lands located at the shores of Sirwanriver and they are irrigated field where the corps grown as mentioned above. In the middle of the valley at upstream is covered heavily by dense shrub communities and includes many kinds of trees.See figure (6.6)

Figure (6.6)CultivatedAgriculturalLandsintheReservoir Area.

6.17. Immigration

Since the riverineenvironmentsaregenerallydynamicandarerepeatedlydestroyedand recreated, Dispersal and migrations are important for most riverine species.Thespeciesmustthereforebeabletospreadandtocolonizenewly created areasasasubstitute forthosethathavevanished.Accesstoforageand resourcesvaries intimeandspace,which makes itimportantformanyanimalstomakeuseofdifferentpartsoftheriversystemduring partsoftheirlifecycles.

Damsactasbarrierswhichobstructthemovementoforganismsthatswimor passivelyfloatonthewater.Many groups oforganismsmaysuffer.Manyaquatic insects,forinstance,reach newareas byvoluntarilyorinvoluntarilyfloatingalong withthestream.Largequantities ofseedsarespreadbyriversinthesameway; someofthesestrandonthebanks,germinateandbecomeestablished. The transportofbothinsectsandseedsisblockedbydams.

Dispersalofplantsbyflowingwaterisalsoobstructedbydams.Largequantitiesofth

eseedsofmanyspeciesaredispersed bytheflowingwatersduringspring floods.Theseedscanbedispersed overlargedistances.Floatingseedscanonly bypassdamsiftheypassthegatesontheoccasionsthatthesearеopen(which areseldom).

6.18. Literacyandawareness

Literacyandawarenessofmany peoplelivingnearthedamsitemaybeincreased bytheeducation gainedaboutusingwaterinirrigationandbywaterusers associationthatmaybedevelopedafterconstructingthedam.

6.19.Employment

Duringtheconstructionphasethefollowingimpactsmayappear:

1. Potential toemploylocalunskilledlabor.
2. Skillstransfertolocalcommunitymembers.
3. holistically,highernumbersofsub-contractors.

Manypeoplehavebenefitedfromtheservicesdamprovide,suchasirrigation. Theirconstruction andoperationcanleadtomanypositivesocialandeconomic impacts.Theactualconstruction ofadamcanprovideemploymentforthelocal communitiesandalsoprovideincentivesforbusinessesandenterprisessetting upshopnearthesiteofthedam.Thiswould bethecasewherethereisincentive todoso.Whenlocalsareabletoworkonthedam,itisonlyforalimitedperiod of timeas whenthe damis completed,the use for laborwill no longerbe required. Ifthereisnootherinvestmentaround theconstructionsite,thenthose employmentopportunitieswilldiminish.

6.20. Otherdevelopmentplans

Thedammaycauseadelayorstoppagefortheotherdevelopment planstobe conductedinthefuture,especiallyforthedevelopmentplansinthereservoirsite oraroundit.

6.21. Infrastructure

The Bardasoor dam may cause negative impacts on the water pump station which it is located at the downstream. Also has an impact on the electric poles of both existing lines.

6.22. Resettlement

Thedamhasnegativeimpactsontheresidentialareaaswellasresettlement especially in the reservoir area. In*Bardasoordam* reservoirsincetheinundation isincludetheresidentpeoplein*Subhan,Banzamin-Mala-Sulaiman and Banzamin-said-muhammed*villages and they must be resttled at minimum 500m far from the reservoir boundary .Also there is a personal rest house in the middle of the Valley of Sirwan River which will be inundated completely by reservoir area.

6.23.Landuse

Economicimpactmayappeardue tothecurrentlandownerandtheleasedueto theinundation.

6.24. Waterpollution

The water quality in the reservoir may lose its auto-regulation and self-purification processes since existing of aquatic plants in the reservoir which it leads to depletion of Oxygen.

6.25. Soilcontamination

Soilcontamination isanotherimpactthatmayappearduringbothconstruction andoperationphases.Duringconstructionphasethecontamination isexpected from operation and maintenanceof trucks and from disposal wastes of the peopleworkingandlivingindamsite.
Duringtheoperationphasethecontaminationofsoilmaybehappeneddueto thepollutedwaterstoredinthereservoir.

6.26. AirandNoisepollution

Regarding to the fact that there are no big producers of air pollution in the

area, it can be claimed that chemical quality of air is good. Physically quality of air is influenced by higher dust caused by local condition especially from the soil and soil cover character. The automobile traffic connected with the gravel mining in the river bed is the biggest source of noise in the area and After Dam construction the strip mining will be inundated by the reservoir basin.AirandNoisepollution willappear duringconstruction phaseof*Bardasoor*damforthepeoplethatworkindam site.

7. PotentialMitigation

Eliminatingalloftheenvironmentalimpactsofa*Bardasoor*dam andreservoir isimpossible.PartoftheexerciseofanEIAistoaccuratelydetermine what environmentalresourcesandecologicalfunctionsstandtobe irreversiblylostasa resultofaproject.Oncethisisknown,decisionmakers mustchoosewhether to acceptthseimpactsinordertogaintheexpectedsocialbenefits.Unfortunately, projectsindeveloping countries oftenproceedwithoutanadequate understandingoftheresultingenvironmental damageandsocialcosts.Ifthe environmental impactsarewellunderstoodandacknowledged andadecisionis madetoproceedwiththeproject,thenattentionshiftstodetermining howbest tomitigateanticipated impacts.Thisiswherethecarefulselectionof environmentalmitigationoptionsiscritical.

Severalmitigationoptionsexistfor*Bardasoor dam*project.Becauseimpactsare usuallysignificantandirreversible, itisrecognizedthatthesemitigationoptions canonlyreduce theseverityofsomeoftheimpacts andnotavoidthementirely. Mitigationoptionsaredescribedinthefollowingpoints:

7.1. OperatingBorrowQuarriesinanAppropriateManner

Since very probable changes in topography and land form of the dam and reservoirsiteareexpected,asmentionedinsection(6.1),goodmitigationis operatingandchoosingborrowquarriesinanappropriatemanner.

7.2. Controlofsedimentmovementinthecatchmentsarea

7.2.1. *Control*of sedimentinflow:

Smallcheckdamsmaybeconstructedonthemaintributariesof*Bardasoor*dama nd on the *Qoratoo*river, therefore existing the proposed Bawanoor dam

project has benefit of reducing the sediment inflow. Vegetation screenonthecatchment wouldgoalongwayinreducing erosion.

7.2.2.Controlof sedimentdeposit:

Theoutletsmaybeopenedatthetimewhenthereismaximuminflowofsediment inthereservoiri.e.duringmonsoonperiods;alsoejectionofreservoirwaterat lowerlevelswouldhelpinreducingsiltinthebasin.

7.2.3. Removalofsedimentdeposit:

Scouring,excavation,dredgingetc.mayberesortedto.Butthesemethodsare expensive.Looseningthesedimentandorpushingittowardsthebottomoutletby mechanicalmeanssimultaneously withscouringwouldincreasetheeffectiveness ofthescouringactiontosomeextent.

7.2.4.Erosioncontrolinthecatchmentsarea

Soilconservation methods,likeaforestation,controlofgrazing,terrace cultivation, provisionofcontourbunds,gullyformationbyprovidingsmall embankments, wherenecessary,debrisbarriers,weedgrowthetc.allhelpto controlsoilerosionandthusreducesedimententryinthereservoir.

7.3. ReductionofSoilErosion

1. Good expectation of rainfalls and Storm water measures to reduce storm water velocity and soil erosion effects.
2. Proper design of roadsand determining the solution and protection method to avoid the soil erosion at road right ways.
3. In case of soil dam, anti-erosioncontrolmeasuressuchasrip-rapwillbecreatedonleadingedgeofdam wall,channelsonfaceofthealltocollectwater,andtoeof damwalltoberockfacedtopreventscour.
4. Vegetation cover and shrubs can prevent banks and shores of reservoir from erosion.
5. Groutingofthefissureswillberequiredinordertosealthewalland foundingareascompletely.

7.4. ArmoringofDownstreamRiverbanks

Armoringandreinforcement ofselectstretchesof*Bardasoor*downstream riverbanks canhelpreducebankerosion. Vulnerable areassuchasbanks subjectedtohighflowvelocities

orthosenearthedamspillway,couldbe reinforced withconcreteorriprap.Armoring i s expensiveandrequiresmaintenancethroughoutthelifeofthedam,butitcanbehelpfulinprotectingagainsttheerosiveforcesofthereleasewater.

7.5. DesignforSpillwayandDam

Correct expectation, accurate and precise design and considering all possibilitycanprotectbanksat both sides of the*Bardasoor*Riverandmakethe reservoir tostorefloods, inflow water from Qoratooriveranddecrease floodpeaks.Thedammustcapabletodischarge incomingflowswhich,forvariousreasons,cannotbestoredin thereservoir (in case inflow exceeds the capacity of the dam). Thedesigncapacityofthespillwaysystemofthedamshould thereforealsobeabletocopewithextremelyhighinflowsto thedam. Thisisofparticularimportanceinthecaseof*Bardasoor*embankmentdam thatdonotwithstandovertoppingofthecrest.

7.6. hydrologicaldesign

١. Manysolutionscanbeconsidered toreduceadverse environmentalimpactscausedby changingthe hydrologicalregimethat notnecessary to reducetheefficacyofthedamintermsofitsmain functions,namelyirrigationandfloodprotection.Multi-purposereservoirs offerenormousscopeforminimizing adverseimpacts.
Inthecaseof drought and lowflows,identifyingdownstream demandsfor irrigation and use todetermine minimumcompensatory lows, both for the natural and human environment,isthekeyrequirementandsuchdemandsneedtobeconsidered atthedesignstage.Theabilitytomimicnaturalflooding mayrequire modificationstotraditionaldamoff take facilities.Inparticular,passingflood flowsearlyintheseasontoenabletimelyrecessionagriculturemayhave theaddedadvantageofpassingflowscarryinghighsedimentloads.
Accuratehydrologicaldesignwillmakeaprecisebalancebetweenthedischarge ofreleasewaterandtheseasonalinflowdischarge.Thereleaseflowmustbe continuousduring theyearaswellassufficientandadequateforthepeople consumptionthatresidedownstreamthedam.

٢. Promotingagriculturalpracticesthatwillreducetheneedforwaterand keepa minimumreleaseforthewaterfromthereservoir.

7.7. RemovalofShrubs and Vegetation Prior to Impoundment

As mentioned before, the area that will be inundated by the reservoir basin is covered by shrubs and vegetation, therefore the area need to be cleared from all vegetation and shrubs before beginning of impoundment. Advantage of Clearingvegetationand shrubs is toavoiddepletionofoxygeninthereservoir.Anabundance of decomposingvegetation and shrubsinareservoircouldalsopotentiallycausestoxiclevelsofmethylmercury inthewaterreleased fromthedam,potentially harmingfishandotheraquaticbiotadownstream. Ideally,the reservoir siteshould becleared andleftfallowforatleastayearpriorto impoundingtoavoidthisandotherproblemsrelatingtodecomposingvegetation and shrubs.

7.8. ReductionofGroundwaterTableImpact

To reduce ground water from contamination, thelandsthatarenearfromthereservoirandmaybe affectedbyitswater levelmustnotbefarmed,or usingdrainagesystems.

7.9. ReductionofGroundwaterQualityImpact

Itdependsonofreservoirwaterquality, improvement of reservoir water quality leads to improve the Ground water quality and subsequently elimination Groundwater Qualityimpacts.

7.10Reduction of water pollution

It will be solved by increasing the fluency of water in the reservoir and by implementation of water instillation treatment station in case of Human use especially of drinking.

7.11. MitigationofThermalStratificationandEutrophication

1. UsingMechanicalaerationtocompensatelagofoxygenresultingfromthe Eutrophicationandmakingmovementandoverturnin somewhereofthe reservoir.
2. Proposingschemesfortheresidencetimeoftheinflowwaterinthe reservoir.

7.12. MitigationofEmploymentImpact

1. UndertakingthattheEmployertakes advantagesofskilledandunskilledlocal laborwherepossible.
2. Utilizetheopportunitytoensurethatskillsaretransferredfromtheskilled laborforceoftheEmployertothelocallaborforce.
3. Therewillbepositiveeffects on the local markets and increases the standard of life.
4. Excellent president experience of large project management and execution.

7.13. MitigationofInfrastructureImpact

١. *Bardasoor*damcan control the amount of discharged water of the existing canal.

٢. To facilitate the transportation between the left side to the right side by construction an access road over the dam.

Thenewroads over the Dam crest formsasa *bridge*. The sides of Sirwnriver valley, whichwasformerly linkedby a bridge (figure(7.1)) far from the project area and located at south of Kalar city which forcingpeople to travel longer distance and throughcrowdedroadsandpaths especially in Kalar city, the crest top roadisbecomingan accessible roadtotravelmuchshorter distancesthanpriortotheconstructionofthedam.Theformationofa DamcouldbeseenasBridge crossing the SirwanRiver.

Figure (7.1) Bridge crossing Sirwanriver located at the SouthEast of kalar city.

٣. Also to passing the existing electricityline over the dam crest properly. Changingthe layoutofthe powerelectricline crossing the Sirwan river and the other electric line along the asphalt road in the left bank and the newlayoutpositions suggestedover the dam crest withits standardlayoutrestrictions for what crossed the Sirwn river.

٤. Construction feeding connection between the dam and the water Pump station to mitigating the impacts.

7.14. MitigationofresettlementImpact

Relocatingthevillages (3 villages) that completely or partially will be inundated by reservoir toanotherfarand safezone.TheNew zonesofthevillagesmustbeawayfromtheprotection areaofthereservoir.

7.15. MitigationofairandNoisePollutionImpact

Usingprotectionfacilitiestopreventpollutionofaircanmitigate thereimpacts. With flooding the gravel mining areas decrease of automobile (especially heavy machines) can be supposed which will also cause decreasing of noise.

7.16. MitigationoflanduseImpact

Compensate the Cultivated lands which exist in the middle and sides of Sirwan valley and located at upstream and it will be inundated after dam construction. Theroadsthat will be inundated by the reservoir must be realigned to another appropriate path and whereneighborhoodthereservoirmustbeprotectedverywellin order toavoiderosion.

7.17. MitigationoftheotherdevelopmentplansImpact

Skillfulnessmanagementfortheotherdevelopmentplanscanmitigatethi sprobable impact.

7.18. MitigationofVegetationImpact

Accurate Hydrological design can control of downstream water demands which it released from the reservoir of Bardasoor Dam and subsequently there will be more opportunity for Vegetation.The adequatedownstreamwaterflowcanbeusedtoirrigateandwiden agriculturallandsandcompensatethevegetationcover.
on the other hand, there arelands at upstream that its elevation is too much above the Sirwan river elevation, and after construction of the dam and reservoir takes it shape, those places will be cultivated lands and orchards even the lands that the difference of elevation not too much or slightly equal can take advantage of Pumping irrigation.

7.19. MitigationofHygieneanddiseasesImpact

1. Instructionsaboutcausesofdisease.
2. Implementation and Improvehealthfacilities.

7.20. MitigationofAquaticlife,TerrestrialwildlifeImpactsandSensitivehabitats Impacts

١. Construction the damencourageswildlife aroundreservoirs.

٢. Taking advantage of developing kinds of Aquatic life especially fishes.

٣. Possibility of forestry around the reservoir.

٤. Rooted aquaticweedsalongtheshoreofthereservoir canbepartially controlledbyalternatedesiccationanddrowning.Insomepartsoftheworldlocalcommunitiesarewillingtode-weedreservoirsandusetheweedsas animalfodder.

7.21. MitigationofEndangeredfaunaandEndangeredfloraImpact

1. Land restriction(inlawandsupportedbyprotectioninstitutions)forflood plains;wetlands;wastewaterdisposalfrom Rusticity or Touristsaround the reservoir tokeepfloraandfauna.
2. Compensation the areas or habitat enhancement outside the projectareamaybeusefulmitigationmeasureswherethenaturalhabitat changeisassessedasdetrimental.

7.22. MitigationofImmigrationImpact

Ecologicalcompensation inotherecosystemswithinthe*Bardasoor*River watershedisanotheroptionthatcouldberequired.Preservationandrestoration ofsensitiveecosystemswithintheimpactedwatershedmustbedone.Particularly valuablenaturalsites(i.e.,eitherfortheirhabitatorwaterqualityfunctions) wouldbe selectedandtheprojectproponentrequiredto purchaseaconservation easementonthesite,therefore protectingitagainstanyfuturedevelopment. Restorationandenhancementofotherdegradedhabitatmustbedone.

8. EnvironmentalMonitoringProgramDuring Dam Construction:

1. Collection ofPre-developmenthydrologicdataincludingseasonalvariations in flow rates and volumes.

2. Residentriparianplantandanimalspeciesshouldalsobedocumented,asthese specieswilllosetheirhabitatwhenthedamimpounds.

3. Baseline water quality parameters which should also be examined include: Biochemical oxygendemand,totalsuspendedsolids,dissolvedoxygen,turbidity, temperatureandmercuryconcentrationsinwaterandsediment.Throughoutthe lifeoftheproject,thesesamewaterqualityparametersshouldcontinuetobe monitored.

4. Reservoirandriverinefishtissuecouldalsobesampledperiodicallyformercuryconce ntrations,asalocalhealthriskmayexistfromtheconsumptionoffishwith highmercurybodyburdens.Fishspeciesandabundances bothupstream and downstreamofthedamshouldalsobemonitoredonanongoingbasis.

5. Environmentalmonitoringofresidentfishspeciesandtheirmigrationpatternsisani mportantcomponentofthe*Bardasoor*EIAprocess.

6. Quantityofsedimenttransportmeasurementsinbothof*Bardasoor*reservoir andriver.

9. EconomicalConsiderations

Thefollowingcostsmustbeaddedtothecostof*Bardasoor*dam:

1. Thecostofin-between Structure project of water pumps station and the dam.

2. Thecostofasphalt road at the left side of the reservoir.

3. Thecostofchangingthelayoutoftheboth electriclineswithinthereservoirarea.

4. ThecostofCompensation of irrigated lands that will be inundated by the reservoir.

5. Thecostofconnected road from Top Crest road and Service roads of the dam to the main road in both sides.

6. Thecostofmechanicalaerationofthereservoirwater.

10. Recommendations

1. Clearly,moreextensivebaselinemonitoringofthenaturalenvironmentpriorto projectapprovalwouldhavebeenusefulinassessingpotentialimpactsandinselectin gappropriate mitigationmethodsforthe*Bardasoor*Damproject. Monitoringofbiologicalandchemical parametersinthewaterandinaquaticbiota canbevitalinalertinggovernment agenciesandlocalcommunities topotential publichealthhazards,suchaselevatedmercuryconcentrationsinfishtissues.

2. Watershedandreservoirprotection

Impoundingreservoirandtheirwatershedareashouldbeprotectedtothedegree necessarytoensurethatthewatersupplyisnotcontaminatedina waythatwould renderitunfitforuse.EPAnowrequiresthatallpublicsuppliesdrawnfromsurface sourcesbefilteredunlessverystringedcriteriawithregardto qualityand protectionaremet.Ifthereservoirisintendedtoprovidewaterwithnotreatment otherthandisinfection,norecreationaluseshouldbepermittedanduseofthe watershedforanypurposeshouldbeseverelyrestrictedwhena complete treatmentplantisprovided.Thereisnoclearhealthreasonforprohibitinglimited recreationalusessuchasfishing,hunting,camping,andbathing. Intheabsenceofstateregulation,thefollowingrulesmightbeapplied[11]:

a. Recreationaluseshouldbepermittedonlywhenthereisa realneedforsuch useandtheneedcannotbesuppliedbyotherbodiesofwater.

b. Useshouldbecontrolledcaretakerswithpoliceauthoritywhosecostsarepaid byfeesassessedagainsttherecreationusersofthelake.

c. Picnicsandcampingshouldberestrictedtoareaswithgarbageandtoiletfacilities.

d. Swimmingandotherwater–contactsportshouldberestrictedtoareasatleast2Km(1.2miles)distancefrominta ke.

e. Noncontactrecreationsuchasfishing,boating,andhuntingshouldberestricted toareasatleast200m(600ft) fromtheintake.

f. Anyresidentialdevelopmentwithinthedrainageareashouldbeprovidedwith sewagetreatmentadequatetoensureprotectionoftheresources.

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