Gungano renyanzvi dzemvura yepasi rinobata pasi rose

# Chikamu chezvinyorwa zvinotevedzana

# MVURA YEPASI UYE NEMABHIZIMUSI ANOCHERA ZVICHERWA

## ZVAKAKOSHA

- Mabhizimusi anochera zvicherwa akanyanya kukosha pahupfumi hwenyika zvinova zvinehukama hwakanyanya nemvura yepasi.
- Mvura yepasi inowanza kukanganisa kucherwa kwezvicherwa, nekuchengetedzeka kwemigodhi yezvicherwa uye kudzivirira matambudziko aya kunoda ruzivo rwemvura yepasi rwakanyanya
- Mvura inoshandiswa pakuchera zvicherwa kwainotorwa kunosiyana nenzvimbo asi nzvimbo dzisinganayi mvura yakawanda dzinoshandisa mvura yepasi zvakanyanya
- Kubuditsa mvura mumugodhi wezvicherwa kunogona kukonzoresa zvakanyanya kushanduka kunoita mafambiro emvura yepasi, nekudaro kukura kwedambudziko iro kunosiyana nemhando yekuburitsa mvura inenge ichishandiswa.
- Mushure mekuvharwa nekuburitswa kwemvura mumugodhi wezvicherwa, mvura yepasi inotanga kuwanda uye panoitika kushanduka kwekuchena kwemvura iyi
- Nhoroondo inoratidza kuti nzvimbo dzaicherwa zvicherwa dzine mvura isina kuchena uye chimiro ichi chigere kugadziriswa.
- Asi mazuva ano zvinoitika pamigodhi yezvicherwa zvinoshandurwa nekushandisa madonzvo anowanika muzvidzidzo zvekuchengetedza nharaunda

## Kucherwa kwezvicherwa nemvura yepasi zvinosangana nenzira dzipi?

Kuchera zvicherwa kunoita kuti mvura yepasi ibudire mumugodhi wezvicherwa, uye kunoshandura kuerera nekuchena kwemvura iyoyi, uye nekudaro kumwewo kuita kunowanikwa pakuchera kunosanganisira kukura kwekuchera, kushanda pakuchera uye kuzovharwa kwemugodhi. Mvura yepasi inogona kukanganisa mari dzinowanika pakuchera zvicherwa kuburikidza nekumisa basa rekuchera uye kukanganisa kuchengetedzeka kwevanhu vanochera, uye nekukanganisa nharaunda.

Kuvhara kwemugodhi wezvicherwa kunoreva kumira kubudiswa kwemvura yepasi zvinova zvichizokonzera mafashamo. Dambudziko iri rinoda kuongororwa zvishoma nezvishoma, kudzoreredzwa nemazano akatambanidzuka uye kuongorora zvakanyanyisa kukwira nekudzika kwepanotangira mvura yepasi, zvinonyunguduka mumvura yepasi uye kukanganisika kunoita nharaunda. Chinhu chikuru pakudzivirira matambudziko akaita seaya kunzwisisa zvakanyanya chimiro chemvura yepasi.

Chinyorwa chino chinobata mhando dzese dzekuchera zvicherwa (makomba akafaranuka uye migero inopinda nepasi) uye kucherwa kwematombo ekuvakisa zvichiederana nehukama hwazvo nemvura yepasi (*sekuiswa kwazvakaitwa mumapoka pachitsauko chinotevera*).

*BOWEN BASIN*
*MUGODHI WEMARASHA_AUSTRALIA*

*This Series is designed both to inform professionals in other sectors of key interactions with groundwater resources and hydrogeological science, and to guide IAH members in their outreach to related sectors.*

| CHIMIRO CHECHIITIKO | KUKANGANISIKA KWEMVURA YEPASI |
|---|---|
| **Kuendeswa kwemvura kumabhizimusi anochera zvicherwa** | Kusangana nevamwe vashandisi vemigodhi vanga vagara varipanzvimbo uye kupera kwemvura zvachose mumatombo epasi anochengeta mvura kunyanya kana pasina mvura irikudzoserwa mumatombo aya, kana kuti ichidzoserwa zvishoma semunzvimbo dzisinganyanyi kunaya mvura |
| **Kuderedza mhepo inesimba inowanika mumatombo nemumvura yepasi kuitira kuti pasi pave pakagadzikana** | Kunyanya mumatombo asinganyanyi kuereramvura uye kukanganisa kushoma kumvura yepasi |
| **Kubuditsa mvura mumugodhi kuti kuchera kuenderere mberi** | Mumugodhi yakakura kana kuti yakadzika kana migodhi inocherwa matombo ekuvakisa zvinokonzeresa kudzika kwemvura kukuru zvichikanganisa vanoshandisa mvura yemumigodhi munharaunda uye miti inoshandisa mvura yepasi. |
| **Kubudikira kunesimba kusingatarisirwe kwemvura ichipinda mumakomba anenge acherwa** | Zvinogona kukonzera kurasikirwa nehupenyu, kuparadzwa kwemidziyo yekucheresa inodhura uye kumisa kuchera kwezvicherwa, zvichikanganisa zvitubu zviripedyo nemiti. |
| **Kuvharwa kwemugodhi zvichikonzeresa kudzoreredzwa kwehwuwandu hwemvura yepasi** | Zvinogona kugadzira nzvimbo itsva dzinobuda nadzo mvura yepasi ichipinda munzizi uye kuunganidzwa kwemvura yakasviba ichipinda munzvimbo yakakura |
| **Kunyungudutsa matombo senzira yekuchera zvicherwa** | Zvinoshandiswa kunyungudutsa matombo zvinogona kukanganisa kuchena kwemvura yepasi |
| **Kukanganisika kwekuchena kwemvura yepasi kunenge kusina kutarisirwa kunokonzerwa nekuchera zvicherwa** | Kubuditswa kwemvura yemumugodhi uye madhamu anorasirwa marara anobuda panocherwa migodhi yezvicherwa zvinoita kuti pakaungana tsvina pasi paite kuti ifambe ichiende kune dzimwe nzvimbo zvinogona kukanganisa kuchena kwemvura yepasi (kunyanya panocherwa marasha kana simbi dzinorema) |

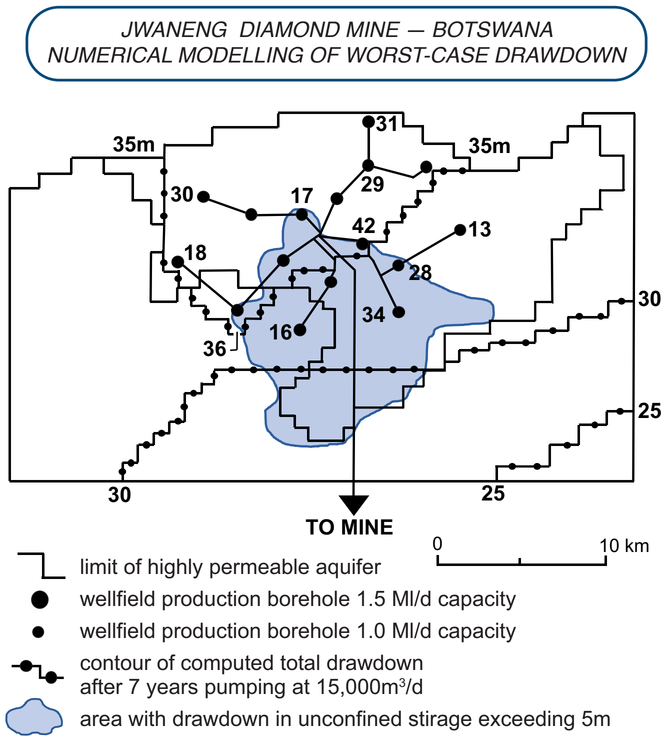
Zvakakosha kuisa mutsauko pakati pekucherwa kwemarasha, kucherwa kwesimbi dzinorema (dzinosanganisira chicherwa che uranium), kwematombo anoyevedza, kwemunyu, kwemajecha.

Uye kucherwa kwematombo ekuvakisa, nekuda kwekusiyana kwemakanganisiro kwazvinoita kutenderera kwemvura panyika. Kune mhando itsva yekuchera zvicherwa irikukosheswa inofanira kucherechedzwa inonzi 'in-situ leaching'. Mhando iyi inonyungudutsa matombo nekutora zvicherwa zvakakosha (zvichisiyana nekubvisa matombo nemhando yekuchera). (*Kugadzirwa kwe Hydrocarbon hakusi muchinyorwa chino, kwakataurwa nezvako mune chikamu chakapfuura mu chinyorwa chimwe*).

## Mvura yepasi yakakosha zvakadini pakucherwa kunoita zvicherwa?

Kucherwa kwezvicherwa, kunge dzimwe nzira dzese dzekugadzira zvinhu kunoda mvura yakawanda kusanganisira mvura inoshandiswa nevanhu. Kucherwa kwezvicherwa padanho repamusoro kunosanganisira kupwanya matombo kuti patorwe matombo akakosha anenge achidiwa (anosanganisira: gold, silver, nema diamonds) zvinoda mvura yakanyanya kuwanda uye basa iri rinogoneka chete kana mvura ichiwanikwa pedyo zvakanyanya. Mvura inoshandiswa pamigodhi yezvicherwa inofanira kuwanika pedyo, asi munzvimbo dzisinganayi mvura yakawanda mvura yepasi ndiyo inonyanya kushandiswa.

Kuvhurwa kweminda yemigodhi yemvura inoshandiswa pakuchera zvicherwa kunofanira kufananidzwa nekucherwa kunoitwa imwe migodhi kusanganisira kuva pasi pemitemo nekupihwa mamepa emutemo ekushandisa. Zvisinei takatarisa pamakore achangobva kupfuura, kushandisa mvura




*nzvimbo yakadzikira mvura nezvikamu zvinopfuura 5 meters*
*Foster et al 1982 Proc Institution of Civil Engineers I: 72: 563-584*

zvakanaka nekudzokorodza kushandisa mvura yamboshanda kurikudzikisa huwandu hwemvura inodiwa pakucherwa zvicherwa. Muenzaniso wekuronga kwekushandisa mvura padanho repamusoro unowanikwa pa Jwaneng Diamond Mine iriku Kalahari munyika yeBotswana. Mvura yaidiwa kuramba ichishandiswa pakutanga inoita iyo.

Zviuru gumi nezvishanu ema m$^3$/pazuva kwemakore makumi nemashanu (zvichida aizogona kupfuura), munzvimbo isina mvura yaizotsiva mvura yepasi inenge yashandiswa uye ine vanhu vanoshandisawo mvura kuchengeta zvipfuwo zvavo zvinofudzirwa muminda yakakura.

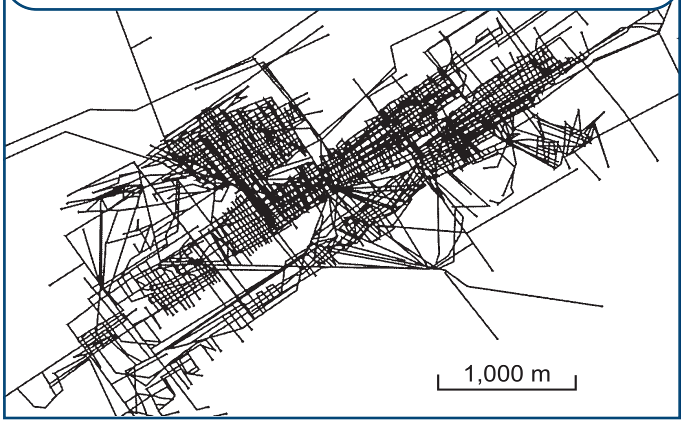
### Kuerera kunoita mvura yepasi kunoshandurwa sei nekubuditswa kwemvura mumugodhi wezvicherwa?

Kuburitsa mvura mumugodhi wezvicherwa panguva dzekuchera kunogona kuva chikonzero chikuru chinoumba kuerera kwemvura panharaunda iripedyo, kunyangwe kuenderana kwemvura yepasi munharaunda yenzvimbo yakakura zvinova zvinokanganisa migodhi yemvura, kuoma kwezvitubu zvichisanaganisira kupinda kwemvura yepasi ichibva munzizi.

Kukura kwedambudziko rinokonzereswa nekubuditsa mvura mumugodhi pamvura yepasi kunosiyana zvichienderana ne mhando inenge yashandiswa:

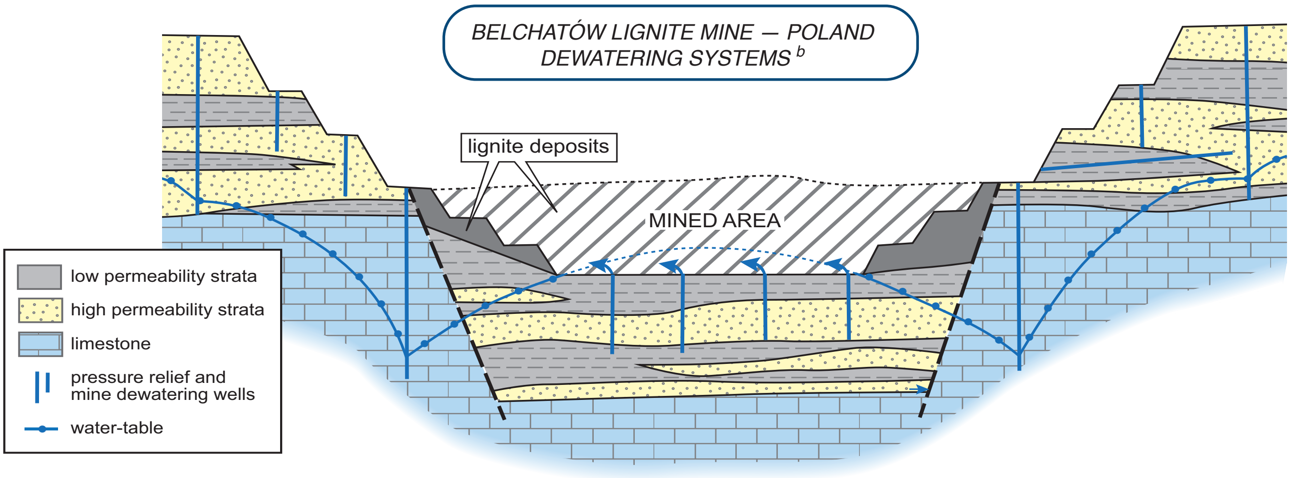
- Kuburitswa zvishoma kwemvura panzvimbo ine matombo asinganyatsi kufambisa mvura ichichengetwa padivi
- Kuburitswa kwemvura nemhepo mumavhu kuti nharaunda igadzikane
- Kuburitswa kwemvura yepasi panzvimbo yakakura nemhando dzekuchera dzakasiyana panzvimbo dzine matombo anofambisa mvura zvakanyanya nechinangwa chekuderedza mafashamo.

*HOMESTAKE GOLD MINE — SOUTH DAKOTA, USA*
*HORIZONTAL PROJECTION OF VOID SPACE FROM TUNNELS AND SHAFTS SPREAD OVER 2,000 METRES DEPTH [d]*




Kuburitswa kwemvura yepasi kunokonzerwa nekucherwa kwezvicherwa kunogona kusvika padanho rakakura. Kunyika yePoland makomba makuru ezvicherwa akashama anova ezvicherwa zve lignite panzvimbo dzinoti Belchatów ne Szczercow mugore ra2017 zvaida migodhi inopfuura mazana mashanu inobuditswa mvura pasi ichibuditsa mazana maviri ema Mm$^3$/pagore rimwe chete (kusanganisira mvura yakachena) zvichikonzera kudzikira kwemvura yepasi nechikamu chinoita 300m, paine mighodhi inosvika chiuru nemazana matatu inoshandiswa kuteverera huhwandu hwemvura yepasi [b]. Kunyika yeEstonia kucherwa kwemafuta anozogadzira zvizhinji zvinosanganisira mafuta anofambisa mota kwaisanganisira kuburitsa mvura inosvika zana namakumi masere ema Mm$^3$/ pagore rimwe chete ichisanganiswa nemvura yepasi mugore ra2002, mvura iyi yaibata chikamu chinoita 70% chemvura yese yepasi yaibuditswa munyika iyi [c].

*BELCHATÓW LIGNITE MINE — POLAND*
*DEWATERING SYSTEMS [b]*




b Kowalczyk et al 2010 Przeglad Geologiczny 58 : 776-788

c Wolkersdorfer & Bowell 2004 Mine Water & Environment 23 : 162-182
d Murdoch et al 2012 Hydrogeology Journal 20 : 27-43

Zvinofanira kucherechedzwa kuti kucherwa kwezvicherwa kwenguva yakareba panzvimbo yakakura kunogadzira mwena yakabatana inofamba nepasi inochinja mafambiro anoita mhepo panzvimbo nekudaro kushandura kuerera kunoita mvura yepasi uye nekuchena kwayo.

Mushure mekuvharwa kwebasa rekuchera uye kumiswa kwekubuditsa mvura yepasi panoitika kudzoreredzwa kwehuhwandu hwemvura yepasi, kutangisa kubuda mvura kwezvitubu ichisangana nemvura yepasi uye kuita mafashamo kwenzvimbo dzakadzikira. Panguva iyi panoitika shanduko yekuchena kwemvura, kunyanya izvo zvine chekuita ne acidification inowanzoitika kunzvimbo dzinocherwa simbi uye dzimwe nzvimbo dzinocherwa marasha.

## Mvura inobuditswa mumughodhi wezvichewa inogona kushandiswa here kupa vanhu kuti vashandise?

Sekudzika kunoita makomba ezvicherwa uye kupfurira kunoita makomba aya panotangira mvura yepasi, kuburitsa mvura yepasi kunowanza kuva nzira yekuwana mvura inoshandiswa panzvimbo iyoyo zvichideredza kutsvagwa kwemvura kubva kunedzimwe nzvimbo dzirikure. Asi, pane dzimwe nguva (semuenzaniso wekucherwa kwe copper munyika ye Chille) zvinoonekwa sezviri nani kusavimba nemvura inobuditswa pakuchera zvicherwa, asi zvinoonekwa senzira yekutora mvurayemhando yakaderera yezvinangwa zvakananga kudzikisakuda kushandisa mvura inobva kudzimwe nzvimbo.

Makore achangopfuura akaonawo mienzaniso yakanaka yekushandisa yemvura yepasi uye kuchengetedzwa kwenzvimbo dzakapoteredza panguva yekushanda kwemugodhi uye nepakuvhara kusanganisira kushandisa zvakare kwemvura yemugodhi kudirirdzira zvirimwa kunzvimbo ye Hunter Valley ku Australia. kukanganisika kwekubviswa kwemvura yepasi panzvimbo dzisina kudzika uye nzvimbo dzinobata mvura kunogona kuderedzwa kubudikidza nezvirongwa zvekuwedzera mvura yemumigodhi sezvirikuitwa kune dzimwe nzvimbo dzeku Australia.

## Kuchena kwemvura yepasi kunodzikira nenzira dzipi zvichikonzerwa nekucherwa kwezvicherwa?

Pane kupokana kudiki kuti mabasa mazhinji ekuchera migodhi, pane imwe nhanho kana imwe, anokonzera kuti pave nemvura zhinji yakasviba.

*POMORZANY — POLAND*
*GROUNDWATER INFLOW TO ZINC & LEAD ORE MINE*

Europe yakayeuchidzwa zvakare nezveizvi nezviitiko zvikuru zvekusvibisa nharaunda zvakaitika ku Aznalcollar (Sevilla) muSpain muna Kubvumbi gore ra1998 uye Baia Mare (Transylvania) muRomania mumwedzi wandira mugore ra2000. Asi njodzi idzi dzakasanganisira kusvibisa kwemvura (kwete mvura yepasi) zvichitevera kutadza kushanda kwemadhamhu anoshandiswa kubata mvura yemugodhi. Mvura dzepasi dziri panjodzi kunyangwe hazvo zvichizoda kuongorora kwakadzama kuti paonekwe mhedzisiro.

Zvimwe zvezvinonyanya kusvibisa mvura yepasi ndezvinoti:

- Kudyika uye kutsemuka kwematombo ku nokonzerwa nekupinda kwemhepo zvinesimba mumigodhi uye kunyura kwemvura yepasi uko kunonyanyoitika kuzvimbo dzinocherwa simbi uye dzimwe nguva kunzvimbo dzinocherwa marasha.
- Mvura iyo inonyura pasi yakasangana nemunyu wematombo uye mvura inenge yakasviba inobva mumigodhi ichipinda pasi. Kunyika yePoland kusviba kwemvura yepasi irimumakomba enzvimbo dzaicherwa simbi kuchiri kuoneka pamhando yemvura yepasi iriko ikezvino kunyangwe migodhi yakavharwa makore makumi matatu apfuura. Izvi zvichiri kuonekwa kuMiddle Jurassic Aquifer nekuonekwa kwehuhwandu hwe iron (270 mg/L), manganese (60 mg/L) uye ne sulphate (1100 mg/L) mumvura yepasi.

Kunyika ye Czech Republic, United States of America (Arizona) uye Kazakhstan kunekunetsekana nenyaya dzezvekusvibisiswa kwemvura yepasi kunyanya kunzvimbo dzinoitwa zvekuchera uranium. Kune hudzamu hwemabasa ezvekucherwa hunogona

kukonzera kusvibiswa kwemvura yepasi izvo zvakawanikwa pakuongororwa kwakaitwa mumakore arikuma 1990 nekuma 2000. Kunyika ye United Kingdom kunenzvimbo inokwana kuita zviuru zvipfumbamwe ema $km^2$ inonzi iripanjodzi dzekusvibiswa ne iron, zinc, copper uye lead zvinonyanyobva mukucherwa kwe marasha uyewo nedzimwe simbi. Kunzvimbo yeSwitzerland kunewo kushushikana kunouya nekusvibiswa kwemvura yepasi nearsenic nekuda kwemabasa ekare ekuchera goridhe.

## Chii chirikuitwa kuderedza matambudziko anowanikwa mumvura yepasi achikonzerwa nekucherwa kwezvicherwa?

Masangano ayo anoita nezvekuongorora mvura anofanha kunyanya kusimbirira kuti mabasa avo asimbe pakuchengetwa kwemvura inomwiwa nekushandiswa nevanhu kuitira kuchengetedzeka kwenharaunda dzinenge dziri pedyo. Izvi zvinoreva kuti masangano aya anofana kunge akazvimirira kuti vagokwanisa kuongorora vemishando iyo inoita nezvekuchera zvicherwa uye kuongorora kwavo hakufanire kuzosiyana nemaongororero avanoita kune mamwe mabhizimusi anoitawo mabasa anokonzera kusviba kwemvura yepasi.

Mamiriro akaita mabhizimusi ezvekuchera migodhi tichirerekera kunyaya dzekusvibiswa kwemvura yepasi kwakanyanya kunokanganiswa nekuda kwenhoroondo dzekusabatwa zvakanaka kwemabhizimusi aya izvo zvinova zvisati zvagadzirirswa kusvika nhasi. Kunyangwe zvichidaro mamiriro emacherero ezvicherwa arikuita achigadziriswa zvichiuyawo nekuiswa kwakaita mabasa ezvekuongororwa nekuchengetedzwa kwenharaunda uye kuchengetedzwa nekubata zvakanaka kwemvura yepasi nekuda kwekugadzirirsa mabatirwo avekuitwa mvura yakasviba inobva mumigodhi. Izvi zvirikuitawo kuti pave nemusiyano wezvaiitwa kare nezvave kuitwa nhasi mazuva ano.

BELCHATÓW LIGNITE MINE — POLAND
WELLS OF THE INNER DEWATERING BARRIER

## Zvingada kuitwa kusimbaradza mitemo nekugara kwakarongeka.

Kune nzira dzinokwanisa kushandiswa pakuchengetedzwa uye kubatwa zvakanaka kwemvura yepasi uko kunokwaniswa kuiswawo mumitemo inoita nezvekucherwa kwemigodhi kunyanya kunhau dzinoita nezvemvura inozomwiwa uye kushandiswa munharaunda painewo mufungo weramangwana. Izvi zvinoti:

- Kunoda kuiswa mitemo inosimbaradza kukosheswa nekuchengetedwa kwemvura yepasi inotevedzera nzira inonzi “cradle to grave” yekuti panova nemutoro unogadadzwa kuti ucherecheredzwe pasati papihwa mvuno yekuchera zvicherwa.
- Panoda ongoororo uye dzidzo yakasimba inoitwa kuti pave nenzira dzinochengetedza uye kudzivirira kusvibiswa kwemvura yepasi mabasa ekuchera asati atanga.
- Panoda kuti pambomiswa dzimwe mhando dzemacherero dzinonyanya kukonzera kusvibiswa kwemvura yepasi
- Panoda kuwedzera kusimbaradza mitemo yemvuno inoita nezvemabatirwo anoitwa mvura yakasviba inobva mumigodhi
- Kusanganisira hurongwa hwemavharirwo angazoitwa migodhi kunyangwe kuchera kusati kwatanga kuitira kuti paoonekwe nzira uye nezvingada kuitikwa kuti tsaona dzidzivirirwe kwenguva yakareba.

## Zvinodiwa paongororo

Donzvo uye zvinangwa zvebasa rekutsoropodza kuparadzwa kwenharaunda zvinodiwa mushure memabasa angaitwe maringe nezvekuchera migodhi kwashanduka mumakore mashoma apfuura uye kwavewo nekuongororwa kwemvura yepasi kutarisa mafambiro uye mamiriro emvura iyi uyewo tsaona dzingaitika uye madzivirirwo adzo.

Basa rekutsoropodza kukanganisika kwenharaunda riri kusimbaradzwa uye riri kuramba richiitwa kubatanidzira kuongorora kuchishandiswa mishini uye nzira dzemazuva ano dzinosanganisira mishini

# MVURA YEPASI UYE NEMABHIZIMUSI ANOCHERA ZVICHERWA

inoongorora zviripasi pevhu, stable uye radioactive isotopes, tracer testing, trace element analyses uye numerical system modelling. Zvakakosha kuti pawane zvinoitwa kuti pave nemabato anozvimirira kuti aongorore mabasa ekutsoropodza kukanganisika kwenharaunda, kuti vagobatsira hurumende pasati paitwa mabasa ezvekuchera. Zvinobuda mubasa rekutsoropodza kukanganisika kwenharaunda zvinoda kuzotevedzerwa uye panoda kuti pave nenzira dzavandudzwa dzekuongororwa kwemvura yakasviba inobuda mumigodhi uye panoda kutariswa zvingazokonzera njodzi kana tsaona mukuchera.

## Nzira dzinoshandiswa pakuvandudza

Kuvakwa ruzhowa rwakasimba pakati pemigodhi yakavhurika uye migodhi inocherwa marasha kunogona kubatsira kuchengetedzeka kwemvura inofamba mumigodhi izvo zvinozoderedza zvinokanganisa mvura isina kudzika pasi zvakanyanya. Ku Witwatersrand Basin-South Africa, kucherwa kwe gold kwakamira asi mamiro akaita mvura yepasi arikuzama kuchengetedzwa kuti ave pasi pehuhwandu hungakonzera tsaona kunharaunda kuburikidza nekuchenesa mvura yakasviba isati yaraswa kana kushandiswa. Kugadzirirswa kwemadhamhu anobata mvura yakasviba inobva kumigodhi kunzvimbo dzaicherwa kare kunogona kuita dambudziko kunyanya kune nzvimbo dzakawanda mabasa ekuchera senyika dzinoti Poland, Germany, China, USA nedzimwewo. Panoda kuwana zvinoitwa zvinova zvakaita seku kuchengetedza madhamu aya zvakanaka kusati kwamirwa kutora mvura yepasi uye mvura yepasi isati yasimuka.

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## ZVAKAKOSHA

- **Kuchengetedzwa nekubatwa zvakanaka kwemvura yepasi kunofanirwa kubatanidzirwa pamitemo yezvekucherwa kubatanzira nekusim baradza nzira yekuchengetedza mitemo iyi nekuisa mari inobatsiridza.**
- **Chikamu chema EIAs chinofanirwa kuitwa mushure mekutendera mabasa angaitwa ekuchera zvicherwa zvichi batanidzirawo kuongororwa kwe mvura yepasi pachishandiswa mishini yechizvino uye nemhando dzakafanira.**
- **Apo panoitwa mabasa ezvekuchera zvicherwa, panofanira kuiswa mitemo uye mienzaniso yakafana kutevedzerwa pakuongorora nekupa umbowo hwe mafambiro emvura yemumigodhi kusanganisira huhwandu hwayo uye nemamiriro ayo.**
- **Kunoda kuiswa nzira dzakasimba, dzinogadzirira tsaona dzekusvibiswa kwemvura yepasi kunokonzerwa ne mabasa ekuchera ayo angave mukati kana kunze kwemigodhi izvo zvinozo batsira pakugadzikana kwemvura nenzvimbo mushure metsaona idzi.**
- **Panoda kuti masangano ezvekuchera, nevanoita zvekuongorora nezvenha-raunda uye vanoita nezvekutarisa mvura dzepasi vabatane kuti pagadziwe nzira dzemubatanidzwa dzinorwisa kusvibiswa kwemvura yepasi**

COORDINATION : Stephen Foster & Gillian Tyson
CONTRIBUTIONS : Wendy Timms, Andrzej Witkowski, Stephen Foot, Peiyue Li & Andrew Johnstone
MANAGEMENT : David Kreamer, Bruce Misstear & Ian Davey Translation : Brian Murove Reviewed: Moses Souta